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EVAPORATION FROM FREE WATER SURFACES

BY

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UNITED STATES DEPARTMENT OF AGRICULTURE, WASHINGTON, D. C.
IN COOPERATION WITH COLORADO AGRICULTURAL
EXPERIMENT STATION

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INTRODUCTION

The storage of water for irrigation has made possible the present irrigation development of those sections of the arid West where the natural stream flows are not sufficient at all times. The loss by evaporation from reservoirs used for the storage of water materially reduces the quantity available for irrigation. This loss is largely unavoidable, but a knowledge of its magnitude and of the factors that influence evaporation is desirable for use in devising means of reducing such losses, in estimating the available supply from existing reservoirs, and in determining the economic feasibility, from the standpoint of evaporation losses, of proposed reservoirs.

[1] Prepared under the direction of W. W. McLaughlin, Chief, Division of Irrigation.

Observations on a sunken tank 3 feet square were started by the Colorado Agricultural Experiment Station in 1887 and have been carried on continuously. As the complexity of the problem became apparent, supplemental experiments were performed, and in 1920 an intensive study of the evaporation problem was started under a cooperative agreement between the Colorado Agricultural Experiment Station and the Division of Agricultural Engineering of the Bureau of Public Roads. This study has had for its objects the determination of the factors that cause evaporation, the derivation of the general law under which these factors operate, and the evaluation of the relation between evaporation as it takes place from various types of standard evaporation tanks and as it is found to occur from a large water surface.

The investigations reported in this bulletin were begun by R. L. Parshall, irrigation engineer, but were later transferred to the author. Since 1926 L. R. Brooks, assistant in irrigation engineering, Colorado Agricultural Experiment Station, has been engaged on the project continuously.

NOTATION AND FORMULAS

NOTATION

The following notation and basic formulas are employed in this bulletin:

E=evaporation in inches per 24 hours.
t_s=mean temperature of the water surface in degrees Fahrenheit.
t_a=mean temperature of the air 1 inch above the water surface in degrees Fahrenheit.
e_s=mean vapor pressure of saturated vapor at the temperature of the water surface, in inches of mercury.
e_d=mean vapor pressure of saturated air at the temperature of the dew point, in inches of mercury.
C=coefficient of the function.
W=mean velocity of ground wind or water-surface wind in miles per hour.
M=slope of the lines used in deriving the formulas.
R=ratio of the observed to the computed evaporation.
B=mean barometer reading, in inches of mercury at 32° Fahrenheit.

FORMULAS

$E=M\ (e_s-e_d)$, (1) page 11.
$M=0.08\ (t_s-t_a+3)^{2/3}$ (2) page 11.
$E=0.08\ (t_s-t_a+3)^{2/3}\ (e_s-e_d)$, (3) page 11.
$E=0.43\ (e_s-e_d)$ for wind velocity of 0 miles per hour, (4a) page 21.
$E=0.64\ (e_s-e_d)$ for wind velocity of 1.5 miles per hour, (4b) page 21.
$E=0.88\ (e_s-e_d)$ for wind velocity of 3.4 miles per hour, (4c) page 21.
$E=1.08\ (e_s-e_d)$ for wind velocity of 5.4 miles per hour, (4d) page 21.
$E=1.36\ (e_s-e_d)$ for wind velocity of 8.3 miles per hour, (4e) page 21.
$E=1.90\ (e_s-e_d)$ for wind velocity of 11.8 miles per hour, (4f) page 21.
$C=(0.44+0.118\ W)$, (5) page 21.
$E=(0.44+0.118\ W)\ (e_s-e_d)$, (6) page 21.
$E=C\ (e_s-e_d)$, (7) page 21.
$R=(1.439-0.0186\ B)$, (8) page 41.
$R=(1.465-0.0186\ B)$, (9) page 42.
$E=(1.465-0.0186\ B)\ (0.44+0.118\ W)\ (e_s-e_d)$, (10) page 42.
$E=0.771\ (1.465-0.0186\ B)\ (0.44+0.118\ W)\ (e_s-e_d)$, (11) page 78.

The computations necessary in obtaining the results reported in this bulletin were made almost exclusively with the slide rule. Errors of one or two units in the last place are to be expected in the results, but these differences are small in proportion to the errors of observation.

EVAPORATION FROMULAS DEVELOPED BY PREVIOUS INVESTIGATORS

The fundamental law of evaporation from a free water surface was discovered by Dalton (*8, p. 574–590*)[2] in 1802. Many experimenters have attempted to determine the mathematical formula expressing the relation discovered by Dalton, but the difficulty of measuring accurately the evaporation losses during time intervals sufficiently short to insure constancy of the meteorological conditions introduced errors that overshadowed the effects of the variables. Moreover, the complex nature of evaporation phenomena and the large number of variables involved rendered difficult the interpretation of observed results.

While the results obtained by the investigators who have attempted to develop a general evaporation formula have been disappointing, several of these formulas deserve mention. In discussing them the terminology used elsewhere in the bulletin is followed where possible; where new terms are necessary or the significance of the terms used is different, their meaning is explained.

Fitzgerald (*11, p. 590, 611*), working in Boston (1876–1887), made a very careful and complete series of observations on evaporation both under controlled conditions in the laboratory and under natural conditions outside. He proposed the formula

$$E=(0.40+0.199\ W)\ (e_s-e_d)$$

which is quite similar to formula 6, p. 21. The principal difference is in the wind factor. Fitzgerald made no correction for the effect of altitude, but he concluded from his experiments that evaporation should increase with the altitude if other conditions remained the same.

Carpenter (*5, p. 50–52*) carried on experiments in 1887 on a sunken tank 3 feet square at the Colorado Agricultural College to determine constants for the Fitzgerald formula applicable to western conditions. From these experiments he derived the formula

$$E=(0.39+0.187\ W)\ (e_s-e_d)$$

which does not differ materially from Fitzgerald's formula.

From observations on the evaporation from Piche evaporimeters at 18 Weather Bureau stations distributed over the United States, Russell (*29*), in 1888, derived the evaporation formula

$$E=\frac{[(1.96\ e_w+43.88)\ (e_w-e_d)]}{B}$$

in which e_w is the vapor pressure, in inches of mercury, corresponding to the mean wet-bulb temperature. This formula takes into account the barometric pressure but not the wind velocity. The constants in the formula were intended to take account of the average wind velocity, and consequently the formula is at best only an approximation.

The Stelling (*33*) formula,

$$E=(0.8424+0.01056\ W)\ (e_s-e_d),$$

[2] Italic numbers in parenthesis refer to Literature Cited, p. 95.

based on pan experiments in Russia (1875–1882), is in metric units. The evaporation E and the difference in vapor pressure $e_s - e_d$ are in millimeters, and the wind velocity W is in meters per second. This formula gives results that are too large.

The most complete series of evaporation experiments ever made was conducted by Bigelow (*3*) (1907–1910) for the United States Weather Bureau. Bigelow made his observations at Reno, Nev., and at the Salton Sea in California. He collected a great mass of evaporation data and developed the formula

$$E = 0.138 \frac{e_s}{e_d} \frac{de}{dS} (1 + 0.07\ W)$$

in which the evaporation E is in centimeters per 24 hours, the vapor pressures e_s and e_d are in millimeters, and the wind velocity W is in kilometers per hour. The term $\frac{de}{dS}$ is the rate of change in the maximum vapor pressure with temperature. Although this formula is based on very complete experimental data, few engineers have accepted it.

From a theoretical study and the results of observations, Horton (*18*) in 1917 developed the formula

$$E = C\ (\psi e_s - e_d)$$

in which C is a coefficient that depends on the size of the tank and ψ is a factor that takes care of the wind. From a theoretical standpoint this formula is worthy of consideration, but, as the values of the constants in the formula have not been definitely determined, the practical value of the formula is small.

The evaporation formula

$$E = (0.5 + 0.05\ W)\ (e_s - e_d)$$

was developed independently by Meyer (*25, p. 1064–1081*), in 1915, and Freeman (*14, p. 123, 134–137*) in 1926. Here W is the wind velocity as measured by the Weather Bureau, and if it is assumed that this is about two and one-half times that of the ground wind, this formula agrees quite closely with formula 6.

Cummings and Richardson (*7*), working on the theory that evaporation is a function of the insolation, propose the formula

$$E = \frac{(H - S - C)}{L\ (1 + R)}$$

in which E is the evaporation, H the net radiation, S the heat stored in a column of water of unit cross section, C a correction for the interchange of heat through the walls surrounding the water, L the latent heat of water, and R Bowen's ratio. This formula is independent of the wind but contains terms that are affected by the altitude. Experiments are being conducted at present to determine the constants of this formula, and the experimental results so far obtained are reported to be very satisfactory.

The Carnegie Institute has published a bulletin on evaporation by Folse (*12, p. 1–130*) in which the formula

$$E=(e_s-e_d)\ [0.319+0.358\ (W-10.8)]$$

is developed as the result of a statistical study of the gauge heights of Lake Superior, Lake Michigan, and Lake Huron, corrected for rainfall, inflow and outflow, barometric pressure, and wind velocity. In this formula only the positive values of the term $(W-10.8)$ are considered; that is, it is assumed that winds of less than 10.8 miles per hour have no effect on evaporation. This does not seem a reasonable assumption and is contrary to the experimental results obtained from evaporation pans.

The foregoing formulas are the results of careful analyses of a large amount of experimental data. Just why a more satisfactory formula has not resulted is not known, unless it is because of the unavoidable inaccuracies in experimental evaporation data.

To overcome the difficulties encountered by previous investigators it was decided that the preliminary studies of the problem should be made under controlled conditions in the laboratory where it would be possible to make relatively accurate observations, and where some of the variables, such as wind and precipitation, could be controlled or eliminated. Additional experiments, the need for which became apparent during the progress of the work, were made either in the laboratory or under natural conditions as seemed best for the solution of the particular problem.

STILL-AIR OBSERVATIONS

EQUIPMENT

The equipment used in the preliminary studies consisted of an evaporation tank, an optical evaporimeter, an aspiration psychrometer, a mercurial barometer, and two accurate thermometers for taking temperatures of the air and water. The equipment was installed inside the laboratory in the calibration tank built for the volumetric measurement of the discharge from water-measuring devices. This tank is 27 by 23.5 feet in plan, and 8.5 feet deep. The walls and floor are of concrete, and the only openings in the walls are the outlet gates which were kept closed.[3] The equipment as installed is shown in Plate 1.

The evaporation tank was 3 feet square and 10 inches deep. It was made of heavy galvanized iron and the top was reinforced by flat iron bars 2 inches wide, firmly bolted to the walls on the inside. These bars, in addition to strengthening the top of the tank, made it possible to measure the dimensions of the tank with a high degree of accuracy. The tank was supported on concrete pedestals 5 inches high, as shown in Plate 1, A.

The optical evaporimeter, for making accurate measurements of extremely small evaporation losses, operated on the principle of the optical lever. It consisted of a cylindrical brass float connected by parallel arms with a pivot bar supported on needle points firmly attached to a concrete pedestal placed close to the evaporation tank, an adjustable mirror attached to the center of the pivot bar, a telescope with its line of collimation intersecting the mirror, and a scale graduated in inches and tenths and so placed that its image was

[3] For a more detailed description of the laboratory see (*6*).

visible in the mirror when viewed through the telescope. Plate 1, B shows the mirror and float. The scale was illuminated to make it visible at night and to render the graduations distinct in the daytime. The length of the supporting arms of the float and the distance of the scale from the mirror determined the magnification. These lengths varied from 0.25 to 0.5 foot for the supporting arms, and approximately from 50 to 75 feet for the scale distance. The first observations were made with the use of plate glass as the mirror, but on account of the double image from the two faces the mirror was later replaced by a carefully ground speculum metal mirror which gave complete satisfaction.

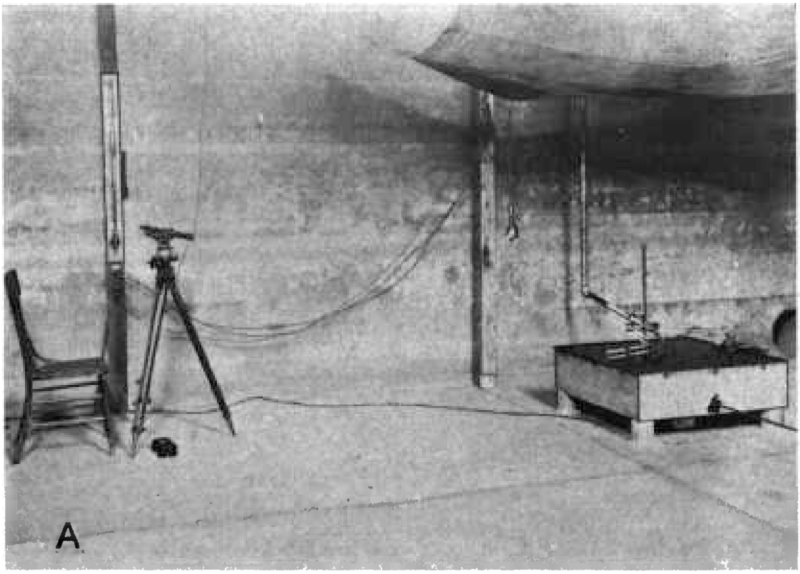
The optical evaporimeter was calibrated by adding known volumes of water to the tank. With a knowledge of the volume of the water added, the area of the tank, and the difference in the scale deflections before and after adding the water, it was easy to compute the constant of the evaporimeter. The value for each 0.01 inch of scale ranged from 0.000016 to 0.000060 inch, depending on the length of the float arm and the scale distance.

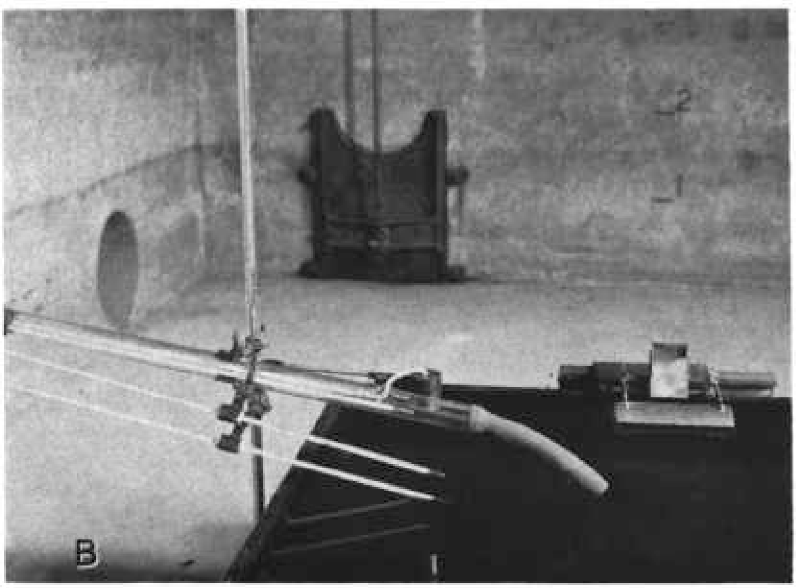
The calibrations were made small increments over the entire range of the scale. The values obtained usually agreed quite closely, but occasionally a single value was considerably in error. The large errors occurred when small quantities of water were added to the evaporation tank. The average maximum deviation from the mean values of the constants for 29 calibrations, excluding those observations made for special purposes and one observation that was manifestly in error, was between 4 and 5 per cent, although for 11 of the calibrations the maximum deviation from the mean was 2 per cent or less.

The aspiration psychrometer, an adaptation of the Assmann psychrometer (*1*), was developed to determine the vapor pressure [4] of the air near the water surface. The apparatus (pl. 1) consisted of wet and dry bulb thermometers graduated in tenths of a degree and fixed inside a 1⅝-inch clear glass tube which was connected by a 1¼-inch pipe to a suction fan so located that the wind from the fan would not disturb the water surface of the evaporation tank. The glass tube containing the thermometers was supported above the evaporation tank, and by means of a short pipe attached to the tube and extending within an inch of the water surface it was possible to draw air from near the water surface. The suction fan was tested to show that it developed an air velocity past the thermometers at least equal to the velocity recommended for sling psychrometers (*23, p. 9–10, 15–56*). The wet-bulb covering was kept moist by a small wick leading from a water reservoir outside the glass tube.

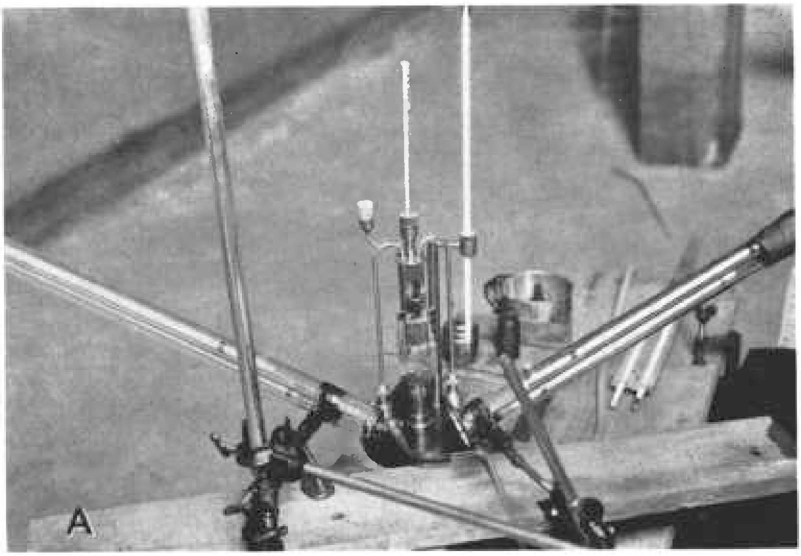
During the first season's observation, simultaneous aspiration-psychrometer and sling-psychrometer readings were taken frequently. Comparison of the results of these observations showed that the vapor pressures computed from the sling-psychrometer readings were consistently lower than those computed from the aspiration-psychrometer readings, the mean deviation of the observations being 4.08 per cent. It was noted that the dry-bulb temperature of the

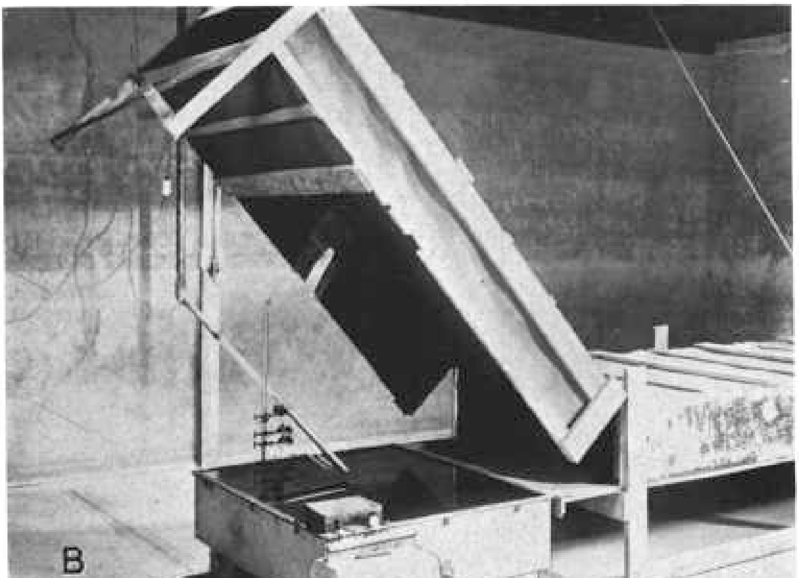
[4] The vapor pressure of the air is the pressure exerted when water is introduced into a closed vessel filled with air and allowed to evaporate. It varies with the temperature and the percentage of saturation of the air. The increase in pressure indicated by a mercury manometer attached to the closed vessel is the measure of the vapor pressure. The pressure increases with evaporation until a condition of equilibrium is reached when no more water will evaporate. The pressure then indicated is the vapor pressure of saturated air. If there is not sufficient water to saturate the air, the pressure increase will be in proportion to the percentage of saturation or the relative humidity.





A, General arrangement of apparatus used in still-air evaporation experiments (the transit was used in reading the thermometers; the telescope for reading the evaporimeter scale is not shown); B, optical evaporimeter, modified Assmann psychrometer, thermometers, and tank used in still-air evaporation experiments





A, Arrangement of apparatus for comparison of Alluard dew-point hygrometer readings with aspiration and sling-psychrometer readings; B, apparatus used in conducting controlled-wind evaporation experiments. Wind tunnel raised to permit making observations sling psychrometer was higher in every instance than the dry-bulb temperature of the aspiration psychrometer, and that the difference between the wet and dry bulb temperatures was also consistently higher for the sling psychrometer. It was impossible to take the sling-psychrometer readings at the water surface, and since the dry-bulb temperatures were different at the point where the sling-psychrometer readings were taken, it is probable that part of the difference in vapor-pressure results was due to the difference in the temperature and humidity at the two points.

In 1923, a series of observations was made for the purpose of comparing the results from the sling and aspiration psychrometers with the results from an Alluard dew-point hygrometer (*27, p. 167–168*). The apparatus for the test is shown in Plate 2, A. Some difficulty was at first experienced in manipulating the dew-point hygrometer, but after the technic was learned consistent results were obtained. Vapor pressures computed from the aspiration and sling-psychrometer readings, as shown in Table 1, were consistently higher than those obtained from the dew-point hygrometer readings, the average difference being about 3 per cent. The small aspiration psychrometer referred to in Table 1 was similar to the large psychrometer and differed only in the length and sensitiveness of the thermometers used. It was employed only in making observations under outside conditions. An attempt was made to check the aspiration psychrometer by direct measurement of the absolute humidity by means of the absorption hygrometer, but satisfactory results could not be obtained.

TABLE 1.—*Comparison of vapor pressures determined by aspiration and sling psychrometers, with vapor pressures determined by Alluard dew-point hygrometer*

Date	Alluard dew-point hygrometer					Psychrometer					
	Temperature				Vapor pressure	Type	Temperature			Vapor pressure	Deviation from hygrometer vapor pressure
	Dew point			Air			Wet bulb	Dry bulb	Difference		
	Dew on	Dew off	Mean								
	° F.	° F.	° F.	° F.	*Inch of mercury*		° F.	° F.	° F.	*Inch of mercury*	*Per cent*
Aug. 6, 1923	[1] 58.91	[1] 58.84	58.88	69.6	0.497	Large aspiration	62.9	69.6	6.7	0.512	+3.0
						Small aspiration	63.1	70.0	6.9	.514	+3.4
						Sling	63.5	70.8	7.3	.518	+4.2
Do	[1] 61.2	[1] 61.2	61.2	71.1	.539	Large aspiration	64.7	71.1	6.4	.551	+2.2
						Small aspiration	65.1	71.5	6.4	.559	+3.7
						Sling	65.4	72.5	7.1	.560	+3.9
Do	61.8	61.8	61.8	71.1	.551	Large aspiration	65.0	71.3	6.3	.558	+1.3
						Small aspiration	66.0	72.0	6.0	.583	+5.8
						Sling	65.5	72.2	6.7	.566	+2.7
Aug. 8, 1923	59.1	59.3	59.2	71.1	.503	Large aspiration	63.9	70.8	6.9	.530	+5.4
						Small aspiration	63.8	71.1	7.3	.524	+4.2
						Sling	64.2	71.8	7.6	.529	+5.2
Do	58.7	59.3	59.0	70.6	.499	Large aspiration	63.7	70.6	6.9	.526	+5.4
						Small aspiration	63.4	70.7	7.3	.516	+3.4
						Sling	64.0	71.1	7.1	.530	+6.2
Do	[1] 63.55	[1] 63.75	63.65	-----	.588	Large aspiration	66.8	72.7	5.9	.602	+2.4
						Small aspiration	66.5	73.1	6.6	.589	+.2
						Sling	67.0	73.8	6.8	.599	+1.9

	Per cent
Mean deviation, large aspiration psychrometer	+3.3
Mean deviation, small aspiration psychrometer	+3.4
Mean deviation, sling psychrometer	+4.0

[1] Mean of 10 readings.

Although small variations in atmospheric pressure apparently have no effect on evaporation, a barometer record was kept to make possible a comparison with the results obtained at different altitudes. For this purpose a mercurial barometer was used which, as shown in Plate 1, A, was mounted near the evaporation tank.

The thermometers for determining the temperature of the air and the water were similar to those used in the psychrometer. They were approximately 24 inches long and were graduated into tenths of degrees from 20° to 120° F. According to the manufacturer, the calibration errors in these thermometers were negligible. They were later compared with a thermometer of the same length and quality, calibrated by the United States Bureau of Standards, and it was found that the calibration errors were less than the experimental errors in the method used. In making evaporation observations, the thermometers were held in place by adjustable clamps attached to a standard near the tank so that the bulb of the water thermometer was just beneath the surface and the bulb of the air thermometer 1 inch above it.

The water used in the evaporation tank was drawn from the municipal supply and was fairly pure. The total solids amounted to about 50 parts per million. After a few days a film formed on the water surface which, it was thought, might affect the results; therefore at the beginning of each series of tests the film was removed by skimming. After cleaning the water surface several hours usually elapsed before the evaporimeter float reached a condition of equilibrium; consequently, after a series of observations was once started all disturbance of the water in the tank was avoided.

OBSERVATIONS

The still-air observations in the laboratory were started in 1920 and were carried on intermittently until 1925. A total of 878 observations were made. Observations were taken hourly in order to reduce to a minimum the variation in the influencing factors in the interval between readings. At first, observations were made only during the day, but it was soon noticed that this procedure did not give reliable results. By the time the equipment attained equilibrium after the preliminary adjustment in the morning, half the period was gone, so this method was abandoned. By extending the series over periods from 24 to 36 hours in length, more reliable results were obtained, and a wider range of conditions was encountered.

A definite routine was observed in making the observations in order to reduce the possibility of error and to render the results comparable to those made under different meteorological conditions. All readings were taken at the beginning and at the end of each observation, but except for the time and scale readings the observations for the end of one test served for the beginning of the next. This method eliminated from the evaporation results the effect of the disturbance created by the observations and was particularly necessary under still-air conditions when even the slightest agitation of the water surface upset the equilibrium of the apparatus. In making the readings, the time was taken to the nearest tenth of a minute. The evaporimeter scale was read directly to tenths and was estimated to hundredths of an inch. The thermometer readings were made to the nearest tenth, except in special cases when the readings were made to hundredths of a degree with a transit telescope.

From these readings the evaporation in inches per 24 hours, the mean temperature, and the vapor pressures and their differences, were computed. These data were plotted, using the mean time as the abscissas and the other variables as the ordinates. The plotted points for each variable, when connected by straight lines, showed graphically the changes that occurred and indicated in a general way—when compared with the plot of the evaporation data—the relation of the different variables to the evaporation. Figure 1 shows the results of a series of observations plotted in this manner. The data for this plot are given in Table 2 (October 23 and 24). This series was not entirely typical, because the temperature of the water, although it dropped considerably during the series, remained constantly higher than the air. Ordinarily, under still-air conditions in the laboratory the water was warmer than the air during the night only, and it was at this time that the maximum evaporation occurred,

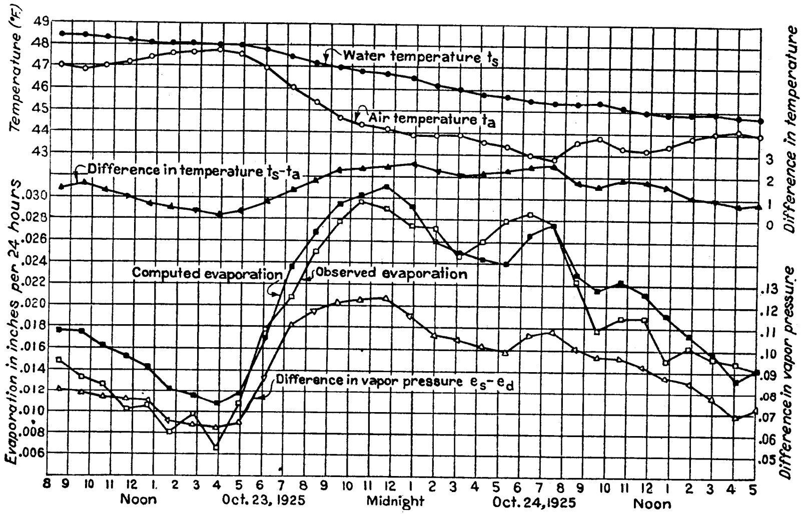


FIGURE 1.—Evaporation as observed and as computed from formula 3 (p. 11) under still-air conditions in the laboratory, Fort Collins, Colo., October 23 and 24, 1925; and relation between the evaporation and the air temperature, water temperature, difference in temperature, and difference in vapor pressure

with the peak at about 6 a. m. This series shows two peaks, which is unusual. It was chosen for presentation here because the relation of the different factors to the evaporation is quite evident.

A study of Figure 1 shows that there is no relation between the evaporation and the temperature of the air or the water, but that there is a definite relation between the difference in temperature of the water and the air, $t_s - t_a$, and the evaporation. The minimum evaporation occurred when the air temperature was a maximum. The most definite relation is shown, however, between the difference in vapor pressure, $e_s - e_d$, and the evaporation, where e_s is the saturated vapor pressure at the temperature of the water surface, and e_d is the vapor pressure at the dew point of the air as computed from the temperatures of the wet and dry bulb thermometers by the use of tables prepared by the United States Department of the Interior for vapor pressure, dew point, and relative humidity. The ratios of the temperatures and the ratios of the vapor pressures show similar relations to the evaporation, but it was found that the differences in temperature and in vapor pressure vary through wider ranges than do the ratios of the same factors, and for that reason the differences were used as the variables in developing the evaporation equation finally adopted.

TABLE 2.—*Evaporation as observed and as computed from formula 3 and pertinent meteorological data for inside conditions without wind at Fort Collins, Colo.*

[Tank, 3 by 3 feet, 10 inches deep]

Date	Time	Mean temperature		Mean difference in vapor pressure, e_s-e_d	Evaporation in 24 hours	
		Air	Water		Observed	Computed
		° F.	*° F.*	*Inch of mercury*	*Inch*	*Inch*
Sept. 15, 1925	6.02 a. m.	59.2	59.7	0.166	0.0392	0.0306
Do	6.56 a. m.	59.2	59.6	.162	.0381	.0293
Do	8.01 a. m.	59.6	59.6	.147	.0267	.0245
Do	9.06 a. m.	60.3	59.6	.124	.0198	.0173
Do	10.17 a. m.	60.8	59.7	.108	.0184	.0133
Do	11.28 a. m.	61.1	59.8	.104	.0123	.0119
Do	12.27 p. m.	61.3	60.0	.103	.0121	.0117
Do	1.26 p. m.	61.7	60.2	.100	.0095	.0105
Do	2.30 p. m.	62.1	60.4	.100	.0099	.0095
Do	3.54 p. m.	62.5	60.8	.104	.0102	.0099
Do	5.17 p. m.	62.9	61.1	.108	.0114	.0098
Do	6.22 p. m.	62.9	61.2	.100	.0111	.0095
Do	7.56 p. m.	62.7	61.4	.094	.0058	.0107
Do	9.24 p. m.	62.6	61.4	.103	.0076	.0122
Do	10.23 p. m.	62.4	61.2	.114	.0081	.0135
Do	11.24 p. m.	62.1	61.1	.129	.0145	.0164
Sept. 16, 1925	1.10 a. m.	61.6	60.8	.145	.0108	.0196
Do	3.17 a. m.	61.2	60.5	.160	.0235	.0223
Do	4.45 a. m.	60.7	60.3	.175	.0322	.0265
Do	6.00 a. m.	60.2	60.2	.182	.0353	.0303
Do	7.03 a. m.	60.2	60.0	.176	.0320	.0280
Do	7.58 a. m.	60.4	60.0	.162	.0229	.0245
Do	8.55 a. m.	60.9	60.0	.147	.0188	.0193
Do	10.04 a. m.	61.3	60.2	.127	.0171	.0156
Do	11.20 a. m.	61.7	60.4	.112	.0111	.0128
Do	12.23 p. m.	62.1	60.6	.106	.0097	.0111
Do	2.20 p. m.	62.8	61.2	.106	.0091	.0106
Do	4.41 p. m.	63.4	61.8	.118	.0086	.0118
Do	6.03 p. m.	63.4	61.8	.133	.0109	.0133
Do	7.47 p. m.	63.2	61.8	.146	.0113	.0160
Do	10.06 p. m.	62.9	61.7	.190	.0090	.0225
Oct. 23, 1925	8.33 a. m.	47.0	48.4	.082	.0148	.0176
Do	9.35 a. m.	46.8	48.4	.079	.0133	.0175
Do	10.38 a. m.	47.0	48.3	.077	.0126	.0163
Do	11.41 a. m.	47.2	48.2	.076	.0101	.0153
Do	12.42 p. m.	47.4	48.1	.075	.0105	.0144
Do	1.45 p. m.	47.6	48.1	.066	.0080	.0122
Do	2.48 p. m.	47.7	48.1	.064	.0098	.0116
Do	3.51 p. m.	47.8	48.0	.063	.0067	.0110
Do	4.55 p. m.	47.6	48.0	.065	.0107	.0118
Do	6.07 p. m.	47.0	47.8	.088	.0179	.0171
Do	7.19 p. m.	46.1	47.5	.110	.0208	.0236
Do	8.24 p. m.	45.4	47.2	.118	.0251	.0269
Do	9.27 p. m.	44.7	47.0	.121	.0279	.0294
Do	10.32 p. m.	44.4	46.8	.123	.0298	.0303
Do	11.44 p. m.	44.2	46.7	.124	.0290	.0310
Oct. 24, 1925	12.55 a. m.	43.9	46.5	.116	.0275	.0293
Do	2.02 a. m.	43.9	46.2	.107	.0272	.0260
Do	3.08 a. m.	43.9	46.0	.105	.0247	.0249
Do	4.14 a. m.	43.6	45.8	.102	.0261	.0245
Do	5.20 a. m.	43.4	45.7	.099	.0279	.0241
Do	6.26 a. m.	43.0	45.5	.107	.0287	.0267
Do	7.30 a. m.	42.8	45.4	.109	.0276	.0275
Do	8.33 a. m.	43.6	45.4	.101	.0224	.0230
Do	9.38 a. m.	43.8	45.4	.097	.0179	.0215
Do	10.42 a. m.	43.3	45.2	.097	.0189	.0224
Do	11.45 a. m.	43.2	45.0	.093	.0190	.0212
Do	12.48 p. m.	43.4	44.9	.088	.0151	.0192
Do	1.52 p. m.	43.8	44.9	.085	.0163	.0174
Do	2.58 p. m.	44.0	44.9	.078	.0153	.0155
Do	4.04 p. m.	44.1	44.8	.069	.0148	.0132
Do	5.07 p. m.	43.9	44.7	.073	.0142	.0142
Mean					.01786	.01873

The results shown are for a single series of observations but the relations indicated, except for isolated cases, hold for all of the observations under still-air conditions.

DERIVATION OF FORMULA

To derive the formula for evaporation under still-air conditions, it was necessary to show graphically the variation of the difference in vapor pressure and of the difference in temperature, with the evaporation. It is obvious that in their original form all these variables could not be plotted at once in a single plane. This difficulty was overcome by plotting the evaporation and the difference in vapor pressure, for a constant value of the temperature difference. These values were obtained from the plots of the original data by taking from the curves the evaporation and the differences in vapor pressure, for constant differences in temperature. These points when plotted formed a series of curves of equal differences in temperature which, for simplicity, were considered to be straight lines of the form

$$E = M\ (e_s - e_d) \qquad (1)$$

in which

$$M = 0.08\ (t_s - t_a + 3)^{\frac{2}{3}} \qquad (2)$$

for the series. Substituting the value of M in formula 1,

$$E = 0.08\ (t_s - t_a + 3)^{\frac{2}{3}}\ (e_s - e_d) \qquad (3)$$

This formula gives results that agree closely with the observed data. A complete analysis of the available data was not made because it was discovered, as will be explained later, that the still-air observations could not be used in the derivation of the general evaporation formula as originally planned. The observed and computed values of two series of observations given in Table 2, and the plot of one of the series in Figure 1, have been included only because they show conclusively the relation between vapor-pressure difference and evaporation.

Formula 3 is empirical and is limited to conditions found in the laboratory. If the air temperature rises more than 3° above the temperature of the water, the formula does not apply, but it is doubtful if it is possible for the air to become more than 3° warmer than the water because the air temperature changes so slowly in the laboratory that the water temperature follows it quite closely.

EFFECT OF TEMPERATURE ON EVAPORATION EQUIPMENT

In comparing the observed and the computed data, occasionally a point was found to be considerably in error, and it was thought that the effect on the apparatus of changes in temperature might cause some of these variations. Doubtless the relative expansion of the tank and water, the rise and the fall of the float due to the change in its size and in the density of the water, the length of the float arm, and the elevation of the pedestal supporting the pivot bearings, were all affected by temperature. However, a determination of the magnitude of the effects of temperature variations on the different parts of the apparatus showed that in general the net effect was small, that the maximum effect was caused by the relative expansion of the water and the metal tank at maximum temperatures, and that the summation of the effects on the different parts of the equipment caused an apparent decrease in the evaporation as the temperature increased. Correcting the observed evaporation for these effects of temperature did not eliminate the inconsistencies in the data. Moreover, since rising temperatures reduce, and falling temperatures increase, the indicated evaporation, it is evident that by taking the means of the observed evaporation losses over a 24-hour period

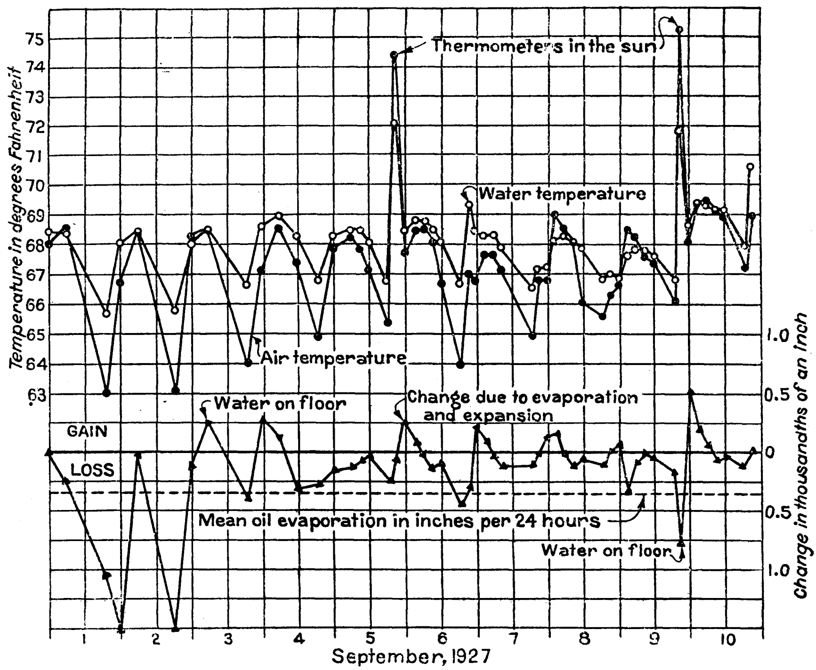


FIGURE 2.—Fluctuation of an oil-covered water surface due to evaporation and expansion, and its relation to the air and water temperatures, Fort Collins, Colo., August 31 to September 10, 1927

the effect of temperature on the apparatus would largely be eliminated.

During the summer of 1927 an attempt was made to measure the temperature effect direct. The apparatus was installed in the evaporation tank as usual, but the water was covered with a film of transformer oil about 0.2 inch in depth to prevent evaporation. Readings were taken several times during the day, usually at 7 a. m., noon, and 6 p. m., but sometimes also at 9 a. m., 3 p. m., 9 p. m., and midnight. The air and water temperatures, the time, and evaporimeter-scale reading were recorded. The results are given in Table 3 and Figure 2.

It was thought that the loss from the oil surface by evaporation would be inappreciable, but as shown in Table 3 there was a gradual loss from the oil or from the water through the oil. Since the oil was about 0.2 inch in depth, it does not seem probable that any of the water escaped through it. The apparent evaporation was small,

TABLE 3.—*Surface fluctuations due to effects of temperature changes on apparatus and to evaporation from oil, Fort Collins, Colo.*

Date	Hour	Temperature		Surface changes			
		Air	Water	Scale reading	Scale difference	Gain or loss [1]	Gain or loss per 24 hours
		°*F.*	°*F.*	*Inches*	*Inch*	*Inch*	*Inch*
Aug. 31, 1927	11.55 a. m.	68.0	68.4	42.69			
Do	6.07 p. m.	68.5	68.4	42.79	+0.10	+0.00026	+0.00101
Sept. 1, 1927	6.45 a. m.	63.0	65.7	43.20	+.41	+.00105	+.00199
Do	12 m.	66.7	68.0	43.79	+.59	+.00151	+.00690
Do	5.45 p. m.	68.4	68.4	43.80	+.01	+.000026	+.000109
Sept. 2, 1927	6.40 a. m.	63.1	65.7	44.39	+.59	+.00151	+.00280
Do	12.15 p. m.	68.2	68.0	44.44	+.05	+.000128	+.000550
Do	5.45 p. m.	68.5	68.5	44.34	−.10	[2] −.00026	−.00113
Sept. 3, 1927	6.45 a. m.	64.0	66.6	44.50	+.16	+.00041	+.000758
Do	12.00 m.	67.1	68.5	44.39	−.11	−.000281	−.00128
Do	5.45 p. m.	68.5	68.9	44.34	−.05	−.000128	−.000534
Do	11.40 p. m.	67.3	68.2	44.46	+.12	+.00031	+.00126
Sept. 4, 1927	6.40 a. m.	68.4	66.7	44.57	+.11	+.00028	+.00096
Do	12.35 p. m.	67.8	68.2	44.51	−.06	−.000154	−.000624
Do	6.30 p. m.	68.2	68.4	44.56	+.05	+.000128	+.000519
Do	9.20 p. m.	67.8	68.4	44.59	+.03	+.000077	+.000652
Do	11.40 p. m.	67.1	68.0	44.60	+.01	+.000026	+.000267
Sept. 5, 1927	6.40 a. m.	65.3	66.7	44.69	+.09	+.00023	+.000787
Do	9.10 a. m.	[3] 74.3	[3] 72.0	44.72	+.03	+.000077	+.000740
Do	12.00 m.	67.6	68.4	44.62	−.10	−.00026	−.00220
Do	3.45 p. m.	68.4	68.7	44.59	−.03	−.000077	−.000493
Do	6.00 p. m.	68.5	68.7	44.60	+.01	+.000026	+.000278
Do	9.05 p. m.	68.0	68.4	44.66	+.06	+.000154	+.00120
Do	11.25 p. m.	66.6	68.0	44.70	+.04	+.000102	+.00105
Sept. 6, 1927	6.45 a. m.	63.9	66.6	44.88	+.18	+.00046	+.00150
Do	9.50 a. m.	66.9	69.3	45.00	+.12	+.000307	+.00239
Do	12.10 p. m.	66.7	68.4	44.91	−.09	−.000230	−.00236
Do	3.10 p. m.	67.6	68.2	44.88	−.03	−.000077	−.000616
Do	6.00 p. m.	67.6	68.2	44.90	+.02	+.000051	+.000432
Do	9.05 p. m.	67.1	67.8	44.95	+.05	+.000128	+.000995
Sept. 7, 1927	6.45 a. m.	64.8	66.4	45.00	+.05	+.000128	+.000318
Do	9.05 a. m.	66.7	67.1	45.01	+.01	+.000026	+.000268
Do	12.00 m.	66.7	67.1	44.96	−.05	−.000128	−.00105
Do	3.00 p. m.	68.9	68.0	44.90	−.06	−.000154	−.00123
Do	5.50 p. m.	68.4	68.2	44.91	+.01	+.000026	+.000220
Do	9.00 p. m.	68.0	68.0	44.96	+.05	+.000128	+.000970
Do	11.30 p. m.	66.0	67.8	44.99	+.03	+.000077	+.000740
Sept. 8, 1927	6.45 a. m.	65.5	66.7	45.04	+.05	+.000128	+.000423
Do	9.15 a. m.	66.2	66.9	45.04	.00	.0000	.0000
Do	11.55 a. m.	66.6	66.7	45.02	−.02	−.000051	−.00046
Do	3.00 p. m.	68.4	67.5	[4] 45.25	+.23	+.000589	+.00458
Do	5.45 p. m.	68.2	67.8	45.29	+.04	+.000102	+.00089
Do	8.55 p. m.	67.5	67.6	45.30	+.01	+.000026	+.000197
Do	11.30 p. m.	67.3	67.5	45.32	+.02	+.000051	+.000474
Sept. 9, 1927	6.45 a. m.	66.0	66.7	45.39	+.07	+.000179	+.000592
Do	9.00 a. m.	[3] 75.2	71.8	45.70	+.31	[5] +.000792	+.00845
Do	12.05 p. m.	68.0	68.5	45.50	−.20	−.000512	−.00399
Do	3.00 p. m.	69.3	69.3	45.43	−.07	−.000179	−.00147
Do	5.45 p. m.	69.4	69.3	45.41	−.02	−.000051	−.000445
Do	9.00 p. m.	69.1	69.1	45.44	+.03	+.000077	+.000569
Do	11.28 p. m.	68.9	69.1	45.46	+.02	+.000051	+.000497
Sept. 10, 1927	6.45 a. m.	67.1	67.8	45.51	+.05	+.000128	+.000421
Do	9.05 a. m.	68.9	70.5	45.51	.00	.0000	.000000

[1] 0.01 inch on scale equals 0.00002556 inch on water surface.
[2] Water ran into calibration tank.
[3] Thermometer in the sun.
[4] Removed spider web from float.
[5] Water leaking into calibration tank from pump sump.

the actual evaporation being obscured by the effect of the temperature changes on the apparatus; but by taking 24-hour intervals the loss became appreciable, and the temperature effect was largely eliminated because the periods were taken from 7 a. m. to 7 a. m. at which time the temperatures were fairly constant from day to day. The mean loss was about 0.0004 inch per 24 hours. This is less than 2 per cent of the loss that would occur from a water surface under similar conditions.

As shown in Figure 2, the changes due to the effect of temperature on the evaporation equipment are partly obscured by the evaporation from the oil surface, but there is a rise and fall of the water surface with the temperature of the water. Inconsistencies occur but these may be due to the change in moisture content of the concrete pedestals supporting the optical evaporimeter and the evaporation tank. Tests show (*24*) that saturating dry concrete with water causes an expansion of 0.042 per cent, which is equivalent to a temperature change of 80° in the concrete. More recent tests on the effect of moisture on concrete show even greater changes (*9, p. 210, 214*).

A comparison of the changes due to temperature and indeterminate causes (Table 3) with the measured evaporation from the evaporation tank under still-air conditions in the laboratory in September, 1925 (Table 2), shows that the maximum changes may exceed the evaporation loss. It should be noted, however, that the maximum change occurred during a period in which water ran into the calibration tank in which the apparatus was located, and probably caused a considerable increase in the moisture content of the concrete pedestals supporting the tank and optical evaporimeter.

OBSERVATIONS WITH CONTROLLED WIND UNDER LABORATORY CONDITIONS

The observations with controlled wind under laboratory conditions were made to determine the effect of wind on evaporation. Knowing the evaporation for still-air conditions in the laboratory, and also the evaporation for the same conditions but with wind of measured velocity, it was thought that by subtracting the former from the latter the increase in evaporation caused by the wind would be obtained. Study of the data, however, showed this belief to be erroneous, and it was necessary to develop a different plan as explained later.

EQUIPMENT

The apparatus was installed in the calibration tank inside the laboratory and was the same as that used in making the still-air observations, except that the tank was placed in an air duct 3 feet wide and 12 inches deep through which air was blown at definite velocities by means of an electric fan. (Pl. 2, B.) In the outlet of the air duct, a standard Robinson anemometer was placed with its axis in the center and its cups just clearing the floor of the duct which was flush with the top of the evaporation tank. Owing to the agitation of the water surface by the wind, the evaporimeter float was installed in a covered stilling well.

The electric fan was placed 11½ feet from the nearest edge of the evaporation tank. This arrangement permitted the wind velocity to become uniform throughout the cross section of the duct before it reached the tank. The wind velocity was regulated by movable shutters which limited the volume of air coming to the fan. Later, in order to increase the velocity more than was possible by opening the shutters, the depth of the air duct was reduced. With this arrangement of the apparatus it was possible to get a maximum wind velocity of 12 miles per hour.

OBSERVATIONS

The observations with controlled wind were started in 1922 and were continued until 1924. During this time a total of 756 hourly observations were made. It was later found necessary to discard the observations made in 1922 because the psychrometer readings were in error, the drying effect of the wind on the wet-bulb sheath being so great that the wick to the reservoir could not supply water fast enough to keep it moist. With the wet bulb only partially moistened, the depresssion in temperature was too small and the computed vapor pressures of the air consequently higher than the true values. This condition was corrected in the later observations by moistening the thermometer at each observation by means of a small pipette.

Except for the wind velocity the readings were the same as those taken during the still-air observations. Owing to the fluctuations in the evaporimeter-scale reading when the wind was blowing, it was necessary to shut off the motor while the scale observations were being made, the scale reading being taken as soon as fluctuation ceased. For the beginning of the next test the scale reading was taken just before starting the motor. The difference in time between the starting and stopping of the motor was used as the time of the test. While the fan was shut off the other observations were also made.

To simplify the interpretation of the data, the wind was held constant for a number of observations while the other factors varied from extraneous causes. Moreover, each series at a given wind velocity was repeated from time to time throughout the season. This gave a wide range of meteorological conditions for each wind velocity.

DERIVATION OF FORMULA

As before stated it was thought that the difference between the still-air observation as computed by formula 3, which is for still-air conditions, and the observed evaporation for a period of known wind velocity would represent the wind effect. It was discovered, however, that these differences had no definite relation to the wind, a circumstance probably due to the complex nature of the variables involved. Factors that influence the evaporation under one set of conditions may fail to exert any appreciable effect under other conditions.

Under still-air conditions, the difference in temperature as between the water and the air exerts a marked influence on evaporation. This is shown in Figure 1 and is expressed mathematically by the factor $(t_s - t_a + 3)^{2/3}$ in formula 3. Since, theoretically, the direct temperature effect is taken care of by the difference in vapor pressure, to the difference-in-temperature factor must be ascribed some of the more obscure temperature phenomena. One of these is convection currents (*18*) which act in a manner similar to the wind in carrying off the vapor from the water surface, and which are the result of differences in temperature as between the air and the water. They increase in magnitude as the temperature of the water increases. For a definite air temperature the value of the factor $(t_s - t_a + 3)^{2/3}$ also increases as the temperature of the water increases. Comparatively, convection currents are of small magnitude and consequently are noticeable only under still-air conditions. Wind movements are stronger than convection currents or at least modify their effect to such an extent that the difference-in-temperature factor bears no apparent relation to the evaporation. This is shown conclusively in Figure 3 which gives the

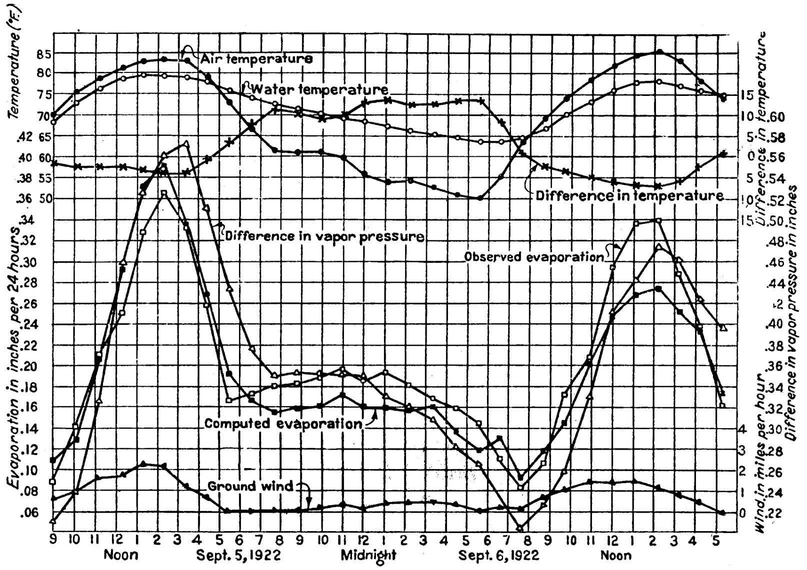


FIGURE 3.—Evaporation as observed and as computed from formula 6 under fully-exposed conditions, Fort Collins, Colo., September 5 and 6, 1922; and relation between the evaporation and the air temperature, water temperature, difference in temperature, difference in vapor pressure, and ground-wind velocity

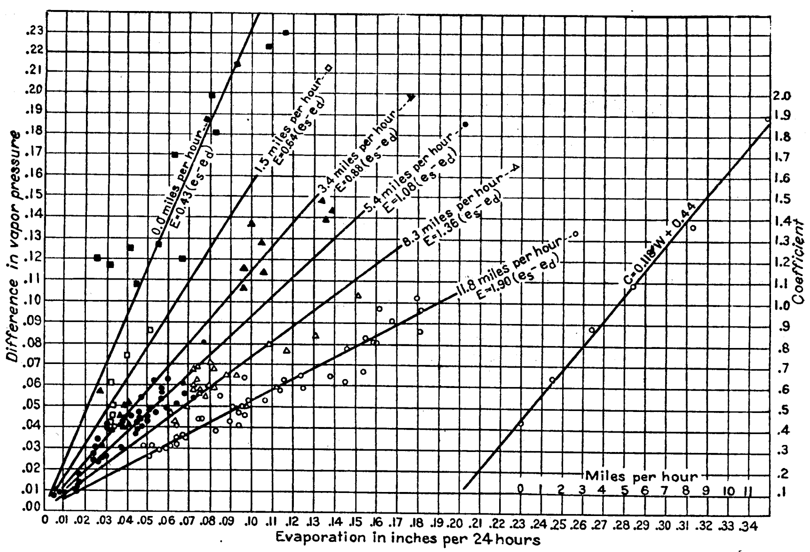


FIGURE 4.—Relation between the evaporation under laboratory conditions of constant winds of different intensities, and the difference in vapor pressure, Fort Collins, Colo., 1923. The diagram gives for each wind velocity the equation of the line showing the relation between evaporation and difference in vapor pressure; also the equation of the line showing the relation between the coefficients in these equations, and the wind velocities

results of evaporation observations with still-air equipment under fully exposed conditions. The formula developed for still-air conditions therefore could not be used in determining the wind effect.

TABLE 4.—*Evaporation as observed and as computed from formula 6 and pertinent meteorological data for inside conditions with controlled wind at Fort Collins, Colo., 1923–24*

Date	Time	Mean temperature: Air	Mean temperature: Water	Mean difference in vapor pressure e_s-e_d	Mean ground wind velocity	Evaporation per 24 hours: Observed	Evaporation per 24 hours: Computed
		°F.	°F.	*In. of mercury*	*Miles per hour*	*Inch*	*Inch*
Sept. 29, 1923	8.52 a. m.	53.4	53.2	0.079	11.97	0.220	0.146
Do	9.56 a. m.	54.3	52.5	.097	11.85	.160	.178
Do	10.59 a. m.	54.9	52.2	.078	11.83	.144	.143
Do	12.06 p. m.	55.4	52.0	.062	11.90	.144	.114
Do	1.13 p. m.	55.8	52.0	.067	11.89	.154	.124
Do	2.17 p. m.	56.0	52.0	.081	11.91	.159	.150
Do	3.21 p. m.	56.3	52.0	.091	11.85	.168	.167
Do	4.25 p. m.	56.6	52.0	.102	11.84	.180	.187
Sept. 30, 1923	8.54 a. m.	55.2	54.4	.096	12.93	.182	.189
Do	10.03 a. m.	55.2	53.9	.083	11.69	.155	.151
Do	11.15 a. m.	55.2	53.6	.072	11.64	.138	.131
Do	12.25 p. m.	55.2	53.3	.063	11.63	.117	.114
Do	1.27 p. m.	55.1	53.2	.058	11.59	.114	.105
Do	2.29 p. m.	55.1	53.1	.053	11.59	.107	.096
Do	3.33 p. m.	55.1	53.0	.046	11.64	.097	.083
Do	4.49 p. m.	55.2	53.0	.041	11.61	.094	.074
Oct. 4, 1923	8.53 a. m.	53.3	53.0	.059	11.63	.125	.107
Do	9.57 a. m.	53.5	52.7	.050	11.67	.096	.091
Do	11.01 a. m.	53.7	52.6	.044	11.65	.075	.080
Do	12.15 p. m.	54.0	52.4	.036	11.71	.067	.066
Do	1.26 p. m.	54.4	52.5	.031	11.69	.052	.056
Do	2.28 p. m.	54.6	52.7	.029	11.69	.056	.053
Do	3.32 p. m.	54.8	52.8	.029	11.75	.058	.053
Do	4.36 p. m.	54.9	52.9	.026	11.68	.051	.047
Oct. 11, 1923	3.06 p. m.	54.9	53.7	.086	11.94	.182	.159
Do	4.10 p. m.	54.5	53.3	.081	11.91	.160	.150
Do	5.09 p. m.	54.4	53.0	.064	11.85	.097	.118
Oct. 12, 1923	8.50 a. m.	50.1	51.2	.103	8.38	.153	.147
Do	9.54 a. m.	50.4	50.6	.084	8.32	.132	.120
Do	10.58 a. m.	50.5	50.2	.077	8.22	.117	.109
Do	12.07 p. m.	50.4	49.9	.071	8.36	.081	.101
Do	1.18 p. m.	50.5	49.6	.068	8.23	.072	.096
Do	2.21 p. m.	50.0	49.4	.065	8.17	.088	.091
Do	3.23 p. m.	50.0	49.2	.059	8.32	.113	.084
Do	4.38 p. m.	50.6	48.9	.047	8.68	.061	.069
Oct. 13, 1923	8.42 a. m.	47.3	48.3	.081	5.42	.077	.087
Do	9.45 a. m.	48.2	47.9	.063	5.45	.060	.068
Do	10.53 a. m.	48.9	47.8	.057	5.42	.057	.062
Do	12.08 p. m.	49.5	47.7	.053	5.46	.057	.058
Do	1.35 p. m.	50.0	47.7	.051	5.42	.064	.055
Do	2.52 p. m.	50.3	47.8	.056	5.38	.068	.060
Do	3.52 p. m.	50.5	47.8	.054	5.40	.072	.058
Do	4.52 p. m.	50.5	47.9	.049	5.40	.059	.053
Oct. 17, 1923	9.00 a. m.	48.4	47.5	.148	3.43	.134	.125
Do	10.04 a. m.	48.9	47.3	.143	3.47	.139	.122
Do	11.08 a. m.	49.1	46.9	.139	3.44	.136	.118
Do	12.15 p. m.	49.5	46.6	.137	3.49	.100	.117
Do	1.20 p. m.	49.6	46.5	.128	3.52	.105	.110
Do	2.28 p. m.	49.8	46.4	.114	3.51	.106	.097
Do	3.35 p. m.	50.1	46.3	.107	3.53	.096	.092
Do	4.42 p. m.	50.2	46.6	.116	3.54	.096	.100
Oct. 23, 1923	8.34 a. m.	46.4	46.0	.055	11.78	.085	.101
Do	9.39 a. m.	46.5	45.7	.050	11.75	.091	.091
Do	10.43 a. m.	46.7	45.6	.047	11.77	.095	.086
Do	11.46 a. m.	46.8	45.5	.044	11.81	.077	.081
Do	12.49 p. m.	46.8	45.4	.041	11.76	.065	.075
Do	1.53 p. m.	46.8	45.3	.035	11.77	.064	.064
Do	2.57 p. m.	46.8	45.3	.031	11.80	.048	.057
Do	4.12 p. m.	46.9	45.3	.031	11.83	.061	.057
Oct. 24, 1923	8.36 a. m.	44.4	44.7	.059	8.32	.082	.084
Do	9.40 a. m.	43.9	44.8	.068	8.36	.083	.097
Do	10.43 a. m.	43.7	44.4	.063	8.31	.074	.089
Do	11.46 a. m.	43.6	44.1	.058	8.32	.072	.084
Do	12.49 p. m.	43.3	43.6	.060	8.33	.072	.085
Do	1.53 p. m.	43.1	43.2	.058	8.32	.076	.083
Do	3.06 p. m.	42.9	42.9	.057	8.35	.076	.081
Oct. 25, 1923	8.26 a. m.	41.0	41.9	.062	5.43	.053	.067
Do	9.30 a. m.	41.2	41.6	.054	5.39	.047	.058
Do	10.34 a. m.	41.5	41.3	.048	5.43	.051	.052
Do	11.37 a. m.	41.7	41.1	.044	5.37	.039	.047
Do	12.38 p. m.	41.9	41.0	.042	5.43	.046	.045
Do	1.40 p. m.	42.0	41.0	.042	5.42	.038	.045

TABLE 4.—*Evaporation as observed and as computed from formula 6 and pertinent meteorological data for inside conditions with controlled wind at Fort Collins, Colo., 1923–24*—Continued

Date	Time	Mean temperature		Mean difference in vapor pressure e_s-e_d	Mean ground wind velocity	Evaporation per 24 hours	
		Air	Water			Observed	Computed
		°F.	°F.	*In. of mercury*	*Miles per hour*	*Inch*	*Inch*
Oct. 25, 1923	2.44 p. m.	42.1	41.0	0.042	5.38	0.044	0.045
Do	3.46 p. m.	42.0	40.9	.043	5.41	.050	.046
Do	4.38 p. m.	41.9	40.8	.044	5.45	.047	.048
Oct. 26, 1923	8.32 a. m.	40.5	40.8	.057	3.31	.027	.047
Do	9.36 a. m.	40.7	40.4	.052	3.36	.041	.044
Do	10.37 a. m.	40.9	40.3	.050	3.36	.039	.042
Do	11.36 a. m.	41.1	40.2	.045	3.38	.037	.038
Do	12.35 p. m.	41.2	40.1	.039	3.34	.033	.033
Do	1.40 p. m.	41.4	40.2	.041	3.39	.037	.034
Do	2.43 p. m.	41.5	40.2	.042	3.36	.038	.035
Do	3.46 p. m.	41.6	40.2	.041	3.39	.041	.034
Do	4.42 p. m.	41.6	40.1	.040	3.35	.038	.033
Oct. 27, 1923	8.38 a. m.	39.0	39.8	.065	11.79	.138	.119
Do	9.41 a. m.	39.2	39.5	.053	11.76	.099	.097
Do	10.44 a. m.	39.4	39.0	.043	11.74	.090	.079
Do	11.47 a. m.	39.6	38.9	.038	11.73	.083	.069
Do	12.51 p. m.	39.7	38.8	.035	11.70	.068	.064
Do	1.56 p. m.	40.0	38.7	.032	11.75	.065	.058
Do	3.00 p. m.	40.2	38.6	.031	11.74	.061	.057
Do	4.14 p. m.	40.3	38.7	.030	11.74	.059	.055
Oct. 29, 1923	8.38 a. m.	37.9	39.3	.080	8.28	.108	.113
Do	9.42 a. m.	38.4	38.7	.069	8.29	.074	.098
Do	10.46 a. m.	38.3	38.3	.065	8.27	.092	.092
Do	11.48 a. m.	38.6	37.9	.060	8.37	.079	.086
Do	12.50 p. m.	38.8	37.8	.055	8.27	.077	.078
Do	1.56 p. m.	38.9	37.7	.050	8.27	.068	.071
Do	3.01 p. m.	39.1	37.7	.043	8.25	.062	.061
Do	4.02 p. m.	38.6	37.6	.050	8.34	.097	.071
Nov. 13, 1923	9.02 a. m.	38.3	39.2	.045	5.28	.042	.048
Do	10.08 a. m.	39.3	39.0	.039	5.39	.031	.042
Do	11.11 a. m.	39.9	38.8	.031	5.41	.028	.033
Do	12.17 p. m.	40.4	38.8	.017	5.40	.017	.018
Do	1.24 p. m.	40.9	38.9	.008	5.39	.008	.009
Do	2.28 p. m.	41.3	39.2	.007	5.35	.005	.008
Do	3.32 p. m.	41.6	39.4	.007	5.37	.010	.008
Do	4.36 p. m.	41.1	39.5	.025	5.39	.028	.027
Do	5.47 p. m.	40.8	39.5	.030	5.40	.037	.032
Do	7.01 p. m.	40.9	39.5	.024	5.40	.024	.026
Do	8.06 p. m.	40.6	39.5	.026	5.41	.030	.028
Do	9.10 p. m.	40.5	39.5	.027	5.35	.024	.029
Do	10.12 p. m.	40.3	39.4	.034	5.45	.026	.037
Do	11.31 p. m.	39.8	39.3	.041	5.43	.031	.044
Nov. 14, 1923	12.50 a. m.	39.1	39.1	.047	5.45	.045	.051
Do	1.51 a. m.	38.7	38.8	.047	5.40	.054	.051
Do	2.55 a. m.	38.3	38.3	.045	5.44	.050	.049
Do	3.59 a. m.	37.9	37.8	.044	5.49	.046	.048
Do	5.32 a. m.	37.4	37.0	.040	5.45	.046	.043
Do	7.05 a. m.	36.9	36.3	.039	5.47	.045	.042
Do	8.08 a. m.	37.3	36.1	.037	5.40	.043	.040
Do	9.12 a. m.	38.2	36.3	.030	5.47	.024	.033
Do	10.19 a. m.	38.8	36.7	.025	5.47	.030	.027
Do	11.22 a. m.	39.4	37.2	.023	5.44	.025	.025
Do	12.22 p. m.	39.9	37.3	.013	5.46	.017	.014
Do	1.24 p. m.	40.4	37.6	.009	5.44	.015	.010
Do	2.28 p. m.	40.9	38.3	.011	5.40	.016	.012
Do	4.33 p. m.	41.2	38.8	.008	5.38	.009	.009
Sept. 23, 1924	9.05 a. m.	53.5	52.2	.087	11.20	.170	.153
Do	10.08 a. m.	54.9	52.0	.070	11.20	.135	.123
Do	11.14 a. m.	55.8	52.0	.058	10.59	.091	.098
Do	12.15 p. m.	56.8	52.2	.047	11.32	.082	.084
Do	1.20 p. m.	56.9	52.5	.035	11.49	.062	.063
Do	2.28 p. m.	57.2	52.9	.025	10.90	.053	.043
Do	3.35 p. m.	58.0	53.4	.027	11.37	.061	.048
Do	4.41 p. m.	58.3	53.7	.028	11.05	.067	.049
Do	5.38 p. m.	58.5	54.1	.029	11.25	.080	.051
Do	6.38 p. m.	56.9	54.3	.025	11.03	.092	.043
Do	7.47 p. m.	54.9	54.3	.039	11.39	.147	.070
Do	8.51 p. m.	54.4	54.2	.063	11.33	.171	.112
Do	9.58 p. m.	53.8	54.0	.070	11.32	.193	.124
Do	11.04 p. m.	54.9	53.7	.075	11.29	.192	.133
Sept. 24, 1924	12.09 a. m.	56.4	53.4	.079	11.33	.186	.140
Do	1.16 a. m.	56.0	53.1	.095	11.28	.201	.168
Do	2.21 a. m.	55.6	52.9	.115	11.25	.205	.204
Do	3.26 a. m.	55.1	52.5	.115	11.39	.208	.205

TABLE 4.—*Evaporation as observed and as computed from formula 6 and pertinent meteorological data for inside conditions with controlled wind at Fort Collins, Colo., 1923–24*—Continued

Date	Time	Mean temperature		Mean difference in vapor pressure e_s-e_d	Mean ground wind velocity	Evaporation per 24 hours	
		Air	Water			Observed	Computed
		°F.	°F.	*In. of mercury*	*Miles per hour*	*Inch*	*Inch*
Sept. 24, 1924	4.33 a. m.	54.7	52.1	0.109	11.40	0.206	0.195
Do	5.37 a. m.	54.3	51.8	.109	11.37	.216	.194
Do	6.40 a. m.	53.8	51.4	.102	11.32	.203	.181
Do	7.44 a. m.	54.3	51.5	.075	11.11	.180	.131
Do	8.48 a. m.	55.3	51.5	.058	11.05	.144	.101
Do	9.52 a. m.	56.2	51.4	.057	11.30	.101	.101
Do	5.23 p. m.	59.8	53.6	.033	12.02	.127	.061
Do	6.31 p. m.	59.5	54.2	.058	11.23	.154	.102
Do	7.25 p. m.	59.2	54.2	.080	11.27	.170	.142
Sept. 26, 1924	2.30 p. m.	54.5	52.6	.143	5.77	.225	.160
Do	3.34 p. m.	54.7	52.0	.135	5.77	.220	.151
Do	4.36 p. m.	54.8	51.7	.129	5.73	.208	.144
Do	5.28 p. m.	53.8	51.4	.135	5.74	.214	.151
Do	6.47 p. m.	52.5	51.0	.145	5.74	.190	.162
Do	8.23 p. m.	52.8	50.4	.130	5.76	.188	.146
Sept. 27, 1924	8.22 a. m.	49.9	50.2	.140	5.72	.179	.156
Do	9.47 a. m.	49.9	49.3	.127	5.70	.163	.141
Do	10.51 a. m.	51.1	49.0	.122	5.75	.149	.136
Do	11.53 a. m.	52.2	48.8	.120	5.81	.151	.135
Do	12.53 p. m.	53.1	48.8	.121	5.86	.150	.137
Do	1.57 p. m.	53.3	48.7	.123	5.85	.150	.139
Do	2.58 p. m.	53.6	48.7	.124	5.85	.157	.140
Do	3.58 p. m.	54.0	48.7	.123	5.80	.154	.138
Do	5.09 p. m.	54.0	48.7	.111	5.85	.142	.125
Do	6.59 p. m.	54.0	48.9	.092	5.82	.119	.104
Sept. 29, 1924	9.34 a. m.	52.7	51.5	.100	2.40	.079	.072
Do	10.40 a. m.	54.4	51.5	.086	1.53	.051	.053
Do	11.38 a. m.	55.2	51.5	.074	1.52	.040	.046
Do	12.44 p. m.	55.7	51.6	.061	1.52	.032	.038
Do	1.54 p. m.	56.0	51.8	.050	1.51	.033	.031
Do	2.58 p. m.	56.3	52.0	.045	1.51	.033	.028
Do	3.55 p. m.	56.6	52.3	.042	1.51	.032	.026
Do	4.56 p. m.	56.8	52.5	.040	1.51	.034	.025
Do	5.58 p. m.	56.6	52.6	.045	1.46	.042	.028
Oct. 28, 1924	9.09 a. m.	50.3	47.9	.127	11.36	.273	.226
Do	10.13 a. m.	51.3	47.3	.132	11.35	.260	.235
Do	11.13 a. m.	51.4	46.9	.119	11.35	.258	.212
Do	12.14 p. m.	51.7	46.6	.110	11.25	.231	.195
Do	1.15 p. m.	52.1	46.7	.115	11.44	.216	.206
Do	2.13 p. m.	52.4	46.2	.103	10.45	.198	.172
Do	3.17 p. m.	52.8	46.7	.104	11.40	.202	.186
Do	4.16 p. m.	53.2	47.5	.108	11.43	.189	.193
Do	5.17 p. m.	53.1	47.2	.109	11.33	.201	.194
Do	6.33 p. m.	52.1	47.4	.112	11.01	.200	.195
Do	7.38 p. m.	51.7	47.4	.113	11.40	.224	.202
Do	8.31 p. m.	52.0	47.2	.117	11.45	.224	.209
Do	9.31 p. m.	51.7	47.1	.120	11.21	.203	.197
Do	10.38 p. m.	51.6	47.0	.117	11.32	.230	.208
Do	11.56 p. m.	51.4	46.8	.103	11.43	.242	.184
Oct. 29, 1924	1.09 a. m.	51.0	46.6	.113	11.45	.234	.202
Do	2.20 a. m.	50.5	46.4	.115	11.34	.232	.205
Do	3.41 a. m.	49.9	45.9	.104	11.45	.226	.186
Do	5.10 a. m.	49.0	45.6	.115	11.35	.223	.205
Do	6.25 a. m.	48.3	45.2	.112	11.44	.221	.201
Do	7.27 a. m.	48.5	44.8	.109	11.31	.216	.194
Do	8.29 a. m.	49.3	44.7	.098	9.41	.176	.152
Do	9.30 a. m.	50.1	44.8	.090	9.33	.171	.139
Do	10.31 a. m.	50.7	44.8	.097	9.20	.163	.148
Do	11.32 a. m.	51.0	45.0	.090	9.68	.150	.142
Do	12.31 p. m.	51.0	45.4	.080	[1] 0.03	.031	.036
Do	1.30 p. m.	51.3	45.7	.069	9.62	.172	.109
Do	2.30 p. m.	52.2	45.8	.068	9.11	.153	.103
Do	3.30 p. m.	52.7	46.2	.080	9.27	.153	.122
Do	4.31 p. m.	52.8	46.4	.096	10.47	.160	.161
Do	5.30 p. m.	52.9	46.6	.090	8.08	.162	.125
Do	6.33 p. m.	53.2	46.8	.080	9.37	.159	.124
Do	7.34 p. m.	52.9	47.0	.084	9.31	.179	.129
Do	8.34 p. m.	52.7	47.1	.088	8.79	.174	.130
Do	9.39 p. m.	52.7	47.1	.084	9.42	.178	.130
Do	10.41 p. m.	52.5	47.1	.091	9.38	.188	.141
Do	11.41 p. m.	51.7	47.0	.104	9.70	.185	.165

[1] Fan off, no wind.

TABLE 4.—*Evaporation as observed and as computed from formula 6 and pertinent meteorological data for inside conditions with controlled wind at Fort Collins, Colo., 1923–24*—Continued

Date	Time	Mean temperature		Mean difference in vapor pressure $e_s - e_d$	Mean ground wind velocity	Evaporation per 24 hours	
		Air	Water			Observed	Computed
		°F.	°F.	*In. of mercury*	*Miles per hour*	*Inch*	*Inch*
Oct. 30, 1924	12.41 a. m.	51.2	46.9	0.102	9.54	0.195	0.160
Do	1.49 a. m.	50.9	46.7	.110	9.55	.204	.173
Do	3.03 a. m.	50.4	46.4	.132	9.58	.216	.207
Do	4.33 a. m.	49.0	45.8	.135	9.38	.242	.209
Do	5.52 a. m.	47.8	45.2	.139	9.38	.254	.215
Do	6.47 a. m.	47.4	44.7	.139	10.49	.264	.234
Do	7.41 a. m.	47.2	44.3	.147	9.33	.245	.226
Do	8.33 a. m.	47.0	44.4	.168	5.11	.185	.175
Do	9.26 a. m.	47.3	44.7	.175	4.25	.148	.165
Do	10.29 a. m.	47.8	44.6	.170	2.86	.135	.132
Do	11.29 a. m.	48.4	44.6	.167	2.40	.123	.121
Do	12.29 p. m.	49.2	44.1	.152	2.56	.121	.113
Do	1.31 p. m.	49.4	43.7	.143	2.43	.136	.104
Do	2.31 p. m.	49.3	43.7	.149	4.53	.175	.145
Do	3.32 p. m.	49.0	43.7	.164	5.97	.191	.188
Do	4.30 p. m.	48.7	43.7	.166	5.64	.169	.184
Do	5.26 p. m.	48.5	43.7	.167	5.15	.166	.175
Do	6.34 p. m.	48.2	43.7	.161	5.73	.168	.180
Do	7.33 p. m.	47.8	43.6	.140	5.14	.142	.147
Do	8.42 p. m.	47.0	43.4	.126	5.59	.164	.139
Do	10.00 p. m.	46.2	43.1	.116	5.71	.167	.129
Do	11.02 p. m.	46.0	42.9	.119	5.44	.155	.129
Oct. 31, 1924	12.10 a. m.	45.6	42.8	.114	5.72	.163	.127
Do	1.21 a. m.	45.2	42.5	.112	5.80	.157	.126
Do	2.29 a. m.	45.0	42.2	.114	5.78	.152	.128
Do	3.42 a. m.	44.7	42.0	.109	5.80	.154	.123
Do	4.48 a. m.	44.3	41.7	.102	5.81	.152	.115
Do	5.50 a. m.	44.0	41.5	.098	5.78	.146	.110
Do	6.48 a. m.	44.5	41.4	.100	5.77	.146	.112
Do	7.46 a. m.	44.7	41.3	.109	5.80	.142	.123
Do	8.39 a. m.	44.8	41.3	.097	4.94	.120	.100
Do	9.31 a. m.	45.4	41.3	.103	5.59	.119	.114
Do	10.33 a. m.	45.7	41.3	.101	5.46	.112	.110
Do	11.29 a. m.	46.5	41.4	.090	5.75	.109	.101
Do	12.30 p. m.	47.3	41.7	.072	5.81	.099	.081
Do	1.31 p. m.	47.8	42.0	.066	5.40	.091	.071
Do	2.30 p. m.	48.8	42.5	.061	3.50	.073	.052
Do	3.35 p. m.	49.2	43.0	.061	3.10	.069	.049
Do	4.34 p. m.	49.4	43.4	.058	2.95	.066	.046
Do	5.35 p. m.	49.3	43.5	.053	1.90	.051	.035
Do	6.35 p. m.	48.9	43.3	.072	3.08	.073	.058
Do	7.35 p. m.	48.6	42.9	.082	3.14	.079	.067
Do	8.40 p. m.	48.0	43.3	.090	2.97	.082	.071
Do	9.55 p. m.	47.9	43.9	.086	2.74	.082	.066
Do	11.02 p. m.	48.0	43.9	.081	3.07	.094	.065
Nov. 1, 1924	12.04 a. m.	47.7	43.9	.105	3.09	.097	.085
Do	1.10 a. m.	47.3	43.8	.110	3.07	.104	.088
Do	2.20 a. m.	46.9	43.8	.112	3.09	.108	.090
Do	3.35 a. m.	46.4	43.7	.116	3.12	.108	.094
Do	5.02 a. m.	46.0	43.5	.111	3.11	.109	.090
Do	6.26 a. m.	45.7	43.3	.114	3.12	.105	.092
Do	7.39 a. m.	45.7	43.3	.114	3.17	.106	.093
Do	8.37 a. m.	46.0	43.3	.117	3.00	.095	.093
Do	9.28 a. m.	46.4	43.3	.120	3.22	.084	.098
Do	10.29 a. m.	46.8	43.2	.108	3.05	.089	.086
Do	11.29 a. m.	47.3	43.0	.087	3.17	.089	.071
Do	12.34 p. m.	47.7	43.1	.081	3.12	.081	.066
Do	1.34 p. m.	48.3	43.3	.084	3.06	.071	.067
Do	2.30 p. m.	48.3	43.5	.079	3.14	.071	.064
Do	3.29 p. m.	48.3	43.8	.077	3.13	.070	.062
Do	4.30 p. m.	48.5	43.9	.078	3.13	.071	.063

Mean 24-hour evaporation in 1923 as observed, 0.0749 inch.
Mean 24-hour evaporation in 1923 as computed, 0.0738 inch.
Mean 24-hour evaporation in 1924 as observed, 0.1483 inch.
Mean 24-hour evaporation in 1924 as computed, 0.1266 inch.

It was observed, however, that for periods of constant wind, there was a definite relation between the evaporation and the difference in vapor pressure, and this fact was made the basis of the new method of attack. Since the observations were taken in series with the wind constant, it was possible to plot the difference in vapor pressure against the evaporation for a definite wind velocity. The controlled-wind observations (Table 4) are shown plotted in this manner in Figure 4. Only the 1923 observations are shown because too many points—particularly when there is considerable dispersion—tend to obscure rather than clarify the relation sought. The line for zero wind in Figure 4 is not based on the still-air observations in the laboratory because it was observed that, when other conditions remained the same, the evaporation under outside conditions for zero wind as indicated by the anemometer, was from three to four times as great as the true still-air evaporation in the laboratory. Accordingly the plotted points for zero wind shown in Figure 4 were taken from the 1922 observations under fully exposed conditions for periods when the anemometer registered no wind. (Table 5.)

Average lines, drawn through the groups of points for the various wind velocities, show how the evaporation varies with the difference in vapor pressure and the wind. The agreement between the lines drawn and the plotted points is far from perfect, but there is apparently a definite relation between the difference in vapor pressure and the evaporation, and for any constant wind the two factors vary according to a straight line relation, the equations of which are of the type:

$$E=M(e_s-e_d). \tag{1}$$

The slope M in formula 1 was computed for each wind velocity and resulted in the following equations:

$$E=0.43\ (e_s-e_d) \text{ for } 0 \text{ miles per hour.} \tag{4a}$$
$$E=0.64\ (e_s-e_d) \text{ for } 1.5 \text{ miles per hour.} \tag{4b}$$
$$E=0.88\ (e_s-e_d) \text{ for } 3.4 \text{ miles per hour.} \tag{4c}$$
$$E=1.08\ (e_s-e_d) \text{ for } 5.4 \text{ miles per hour.} \tag{4d}$$
$$E=1.36\ (e_s-e_d) \text{ for } 8.3 \text{ miles per hour.} \tag{4e}$$
$$E=1.90\ (e_s-e_d) \text{ for } 11.8 \text{ miles per hour.} \tag{4f}$$

These slopes when plotted against the wind velocity, as shown in Figure 4, resulted in a straight line having the equation

$$C=(0.44+0.118W) \tag{5}$$

where C is the coefficient and W is the wind velocity in miles per hour. Substituting for M in formula 1 its value $(0.44+0.118\ W)$, gives the formula for controlled wind conditions,

$$E=(0.44+0.118\ W)\ (e_s-e_d) \tag{6}$$

which, it will be noted, is of the same form as Dalton's original formula

$$E=C(e_s-e_d), \tag{7}$$

because for each wind velocity the factor $(0.44+0.118\ W)$ is a constant.

The computed results for the 1923 observations (Table 4) agreed quite closely with the observed evaporation, as was to be expected because the formula was derived from these observations; but the computed results for the 1924 observations were, in general, less than the observed figures. The reason for this is not clear.

OUTSIDE OBSERVATIONS UNDER FULLY EXPOSED CONDITIONS

During 1922 and 1923, evaporation observations were made under outside conditions with the tank fully exposed for the purpose of testing, under natural conditions, evaporation formula 6 as derived from laboratory experiments. The equipment (pl. 3, A) was similar to that used in the experiments under still-air conditions in the laboratory, except that the evaporation tank was 18 inches deep instead of 10 and was sunk in the ground instead of being fully exposed. Less sensitive thermometers were used in the psychrometer, but the tests made in 1923 (Table 1) showed that the mean results from the small aspiration psychrometer agreed almost exactly with those from the large one. The psychrometer and the air and water thermometers were protected from the direct rays of the sun, and the optical-evaporimeter float was installed in a covered stilling well attached to the outside of the evaporation tank.

A standard Robinson anemometer was used in determining the wind velocity. As shown in Plate 3, A, the anemometer cups were not at the level of the top of the tank, and consequently it was necessary to reduce the indicated velocities to the ground velocities. This was done by the use of a comparison diagram based on experiments made on Robinson anemometers at the level shown and near the ground surface.

The observations were made hourly, usually in series of from 24 to 36 hours, a total of 278 observations being made. As in the case of the still-air observations, the time and evaporimeter-scale readings were taken at the beginning and end of each test, and the other readings in the interval between the scale reading at the end of one test and at the beginning of the next.

The results of these observations and the evaporation as computed by formula 6 for the same conditions are given in tabular form in Table 5, and one series of observations is shown graphically in Figure 3. A comparison of the observed and computed results shows that there is considerable variation in the individual observations, but that the mean values do not differ materially. Precise agreement is not to be expected because of the differences between the conditions under which the formula was derived and those found outside, particularly in respect to the wind.

TABLE 5.—*Evaporation as observed and as computed from formula 6 (p. 21) and pertinent meteorological data for outside conditions at Fort Collins, Colo., 1922–23*

[Tank, 3 by 3 feet, 18 inches deep]

Date	Time	Mean temperature		Mean difference in vapor pressure e_s-e_d	Mean ground wind velocity	Evaporation per 24 hours	
		Air	Water			Observed	Computed
		°F.	°F.	Inch of mercury	Miles per hour	Inch	Inch
Sept. 5, 1922	9.02 a. m.	69.8	68.1	0.210	0.64	0.087	0.108
Do	10.04 a. m.	75.2	72.7	.237	.90	.140	.129
Do	11.10 a. m.	78.8	76.3	.325	1.64	.210	.206
Do	12.16 p. m.	81.0	78.8	.460	1.68	.250	.293
Do	1.17 p. m.	82.8	79.7	.526	2.27	.328	.372
Do	2.21 p. m.	83.2	79.3	.562	2.19	.367	.392
Do	3.23 p. m.	82.9	79.0	.573	1.23	.331	.335
Do	4.27 p. m.	79.0	78.0	.511	.73	.259	.269
Do	5.31 p. m.	72.7	75.9	.434	.00	.166	.191
Do	6.38 p. m.	66.3	74.1	.377	.00	.172	.166
Do	7.45 p. m.	61.4	72.6	.349	.00	.179	.154
Do	8.48 p. m.	60.9	71.3	.353	.08	.182	.158
Do	9.45 p. m.	61.1	70.2	.352	.15	.188	.161
Do	10.58 p. m.	59.6	69.2	.353	.38	.196	.171
Sept. 6, 1922	12.03 a. m.	55.7	68.4	.350	.14	.185	.160
Do	1.09 a. m.	53.9	67.4	.331	.35	.193	.159
Do	2.15 a. m.	54.1	66.2	.319	.44	.181	.157
Do	3.21 a. m.	52.6	65.3	.307	.41	.168	.150
Do	4.28 a. m.	50.9	64.5	.282	.36	.159	.136
Do	5.34 a. m.	50.0	63.5	.265	.06	.144	.118
Do	6.36 a. m.	55.1	63.4	.278	.21	.110	.129
Do	7.37 a. m.	63.6	64.4	.203	.12	.081	.092
Do	8.41 a. m.	69.2	66.7	.227	.68	.107	.118
Do	9.43 a. m.	73.7	70.2	.258	1.04	.172	.145
Do	10.51 a. m.	78.5	73.5	.328	1.48	.209	.202
Do	11.59 a. m.	82.0	76.0	.412	1.39	.294	.249
Do	1.04 p. m.	84.5	77.6	.442	1.43	.336	.269
Do	2.10 p. m.	85.4	78.0	.473	1.19	.339	.274
Do	3.13 p. m.	82.9	76.9	.462	.88	.289	.251
Do	4.14 p. m.	78.2	75.8	.424	.57	.239	.215
Do	5.19 p. m.	73.8	74.5	.396	.00	.161	.174
Sept. 19, 1922	9.05 a. m.	58.3	59.0	.164	.00	.130	.072
Do	10.10 a. m.	63.4	63.6	.233	.00	.130	.103
Do	11.14 a. m.	67.6	68.0	.316	.00	.116	.139
Do	12.20 p. m.	70.5	71.1	.411	.29	.168	.195
Do	1.26 p. m.	72.3	72.7	.458	.32	.199	.219
Do	2.33 p. m.	73.0	73.5	.491	.37	.243	.238
Do	3.44 p. m.	71.8	73.0	.495	.18	.237	.228
Do	4.48 p. m.	65.9	70.7	.429	.00	.158	.189
Do	5.52 p. m.	58.5	67.9	.364	.00	.137	.160
Do	6.56 p. m.	54.4	65.9	.342	.00	.143	.150
Do	8.00 p. m.	52.0	64.1	.324	.00	.154	.142
Do	9.06 p. m.	50.6	62.7	.305	.00	.140	.134
Do	10.13 p. m.	49.6	61.7	.315	.00	.154	.139
Do	11.21 p. m.	47.0	60.7	.305	.00	.136	.134
Sept. 20, 1922	2.45 a. m.	41.1	57.5	.258	.00	.131	.114
Do	3.50 a. m.	40.0	57.0	.250	.00	.104	.110
Do	4.57 a. m.	39.1	56.1	.230	.00	.116	.101
Do	6.01 a. m.	38.6	55.1	.223	.00	.108	.098
Do	7.11 a. m.	46.1	55.5	.199	.00	.081	.088
Do	8.20 a. m.	56.6	57.5	.181	.00	.083	.080
Do	10.44 a. m.	71.8	67.4	.349	.16	.143	.160
Do	11.48 a. m.	76.1	71.4	.432	.28	.200	.204
Do	1.01 p. m.	78.3	73.9	.517	.20	.218	.240
Do	2.12 p. m.	79.0	75.2	.598	.14	.241	.273
Do	3.17 p. m.	79.3	75.5	.507	.10	.240	.229
Do	4.24 p. m.	73.2	73.3	.451	.00	.173	.199
Do	5.35 p. m.	61.6	69.6	.375	.00	.129	.165
Do	6.42 p. m.	55.2	67.0	.348	.00	.172	.153
Do	7.48 p. m.	51.8	65.0	.337	.00	.153	.148
Do	8.54 p. m.	48.6	62.0	.294	.00	.168	.129
Do	9.54 p. m.	49.2	62.4	.316	.00	.153	.139
Do	11.00 p. m.	48.0	61.4	.306	.00	.142	.135
Sept. 21, 1922	12.05 a. m.	45.9	60.4	.293	.43	.151	.144
Do	1.10 a. m.	43.9	59.3	.284	.00	.128	.125
Do	2.16 a. m.	41.4	58.3	.276	.00	.128	.121
Do	3.23 a. m.	41.8	57.4	.265	.00	.123	.117
Do	4.28 a. m.	40.8	56.5	.262	.00	.120	.115
Do	5.34 a. m.	39.1	55.7	.254	.00	.113	.112
Do	6.41 a. m.	46.2	55.5	.214	.00	.093	.094
Do	7.46 a. m.	55.8	56.4	.170	.00	.063	.075
Do	8.53 a. m.	64.5	60.2	.205	.00	.116	.090
Do	9.58 a. m.	73.0	65.6	.320	.34	.202	.154
Do	11.04 a. m.	77.1	70.1	.441	.23	.216	.206

TABLE 5.—*Evaporation as observed and as computed from formula 6 (p. 21) and pertinent meteorological data for outside conditions at Fort Collins, Colo., 1922–23*—Continued

Date	Time	Mean temperature		Mean difference in vapor pressure $e_s - e_d$	Mean ground wind velocity	Evaporation per 24 hours	
		Air	Water			Observed	Computed
		°F.	°F.	Inch of mercury	Miles per hour	Inch	Inch
Sept. 21, 1922	12.10 p. m.	79.6	73.2	0.533	0.16	0.222	0.254
Do	1.16 p. m.	80.5	74.8	.585	.27	.265	.276
Do	2.22 p. m.	81.0	75.2	.605	.45	.297	.298
Do	3.27 p. m.	79.0	74.6	.582	.40	.332	.284
Do	4.33 p. m.	71.0	72.0	.528	.18	.185	.244
Oct. 12, 1922	3.49 p. m.	50.5	49.0	.173	1.08	.131	.098
Do	4.56 p. m.	47.8	48.6	.160	.98	[1] .031	.089
Do	6.02 p. m.	45.4	48.1	.155	.11	.068	.070
Do	7.10 p. m.	42.9	47.7	.154	.07	.070	.069
Do	8.16 p. m.	40.8	47.3	.155	.06	.067	.069
Do	9.23 p. m.	39.0	46.7	.150	.42	.076	.074
Do	10.30 p. m.	38.0	46.2	.140	.00	.055	.062
Do	11.36 p. m.	37.2	45.6	.130	.00	.056	.057
Oct. 13, 1922	12.41 a. m.	36.2	45.2	.125	.00	.052	.055
Do	1.46 a. m.	47.2	44.9	.125	.00	.041	.055
Do	2.52 a. m.	36.1	44.4	.122	.00	.058	.054
Do	3.58 a. m.	34.3	44.5	.127	.08	.051	.057
Do	5.04 a. m.	34.4	43.6	.121	.23	.056	.057
Do	6.08 a. m.	36.5	43.0	.118	.08	.050	.053
Do	7.12 a. m.	45.3	42.9	.106	3.13	.111	.086
Do	8.15 a. m.	51.9	44.2	.101	4.34	.141	.096
Do	9.25 a. m.	53.8	46.1	.107	6.28	.164	.126
Do	10.35 a. m.	56.2	49.1	.128	5.45	.181	.139
Do	11.41 a. m.	54.5	51.0	.149	4.62	.175	.147
Do	12.46 p. m.	55.0	52.0	.163	4.29	.167	.154
Do	1.54 p. m.	54.0	52.5	.170	5.07	.191	.177
Do	2.58 p. m.	48.0	51.0	.155	5.17	.168	.163
Do	4.04 p. m.	44.1	49.1	.136	4.43	.158	.131
Do	7.22 p. m.	41.6	47.8	.115	1.49	.086	.071
Do	8.26 p. m.	42.0	47.6	.118	.38	.050	.057
Do	9.33 p. m.	42.5	47.3	.111	.12	.064	.050
Do	10.41 p. m.	42.7	47.1	.125	.37	.016	.061
Do	11.49 p. m.	42.2	47.0	.132	.00	.035	.058
Oct. 14, 1922	12.53 a. m.	42.0	47.0	.120	.00	.025	.053
Do	2.00 a. m.	42.0	46.7	.117	.00	.031	.052
Do	3.06 a. m.	40.5	46.3	.117	.00	.031	.052
Do	4.12 a. m.	35.6	45.7	.127	.00	.054	.056
Do	5.20 a. m.	32.6	44.8	.125	.00	.042	.055
Do	6.27 a. m.	35.0	44.7	.120	.00	.066	.053
Do	7.34 a. m.	38.0	44.9	.108	.00	.043	.048
Do	8.38 a. m.	35.9	44.9	.089	.11	.029	.040
Do	9.43 a. m.	45.4	46.2	.101	1.12	.078	.058
Do	10.46 a. m.	48.9	49.4	.137	1.73	.109	.089
Do	11.52 a. m.	52.2	53.2	.171	1.40	.121	.104
Do	12.57 p. m.	54.6	55.4	.195	.68	.092	.101
Do	2.04 p. m.	57.9	56.9	.203	.57	.119	.103
Do	3.10 p. m.	57.7	56.8	.199	.36	.093	.096
Do	4.15 p. m.	52.8	54.8	.191	.00	.058	.084
Do	5.20 p. m.	46.8	52.6	.174	.00	.046	.076
Oct. 27, 1922	8.37 a. m.	48.2	41.5	.101	.23	.047	.047
Do	9.42 a. m.	53.9	44.0	.098	.09	.052	.044
Do	10.46 a. m.	58.6	46.4	.105	.31	.061	.050
Do	11.50 a. m.	59.6	48.3	.115	.36	.063	.056
Do	12.54 p. m.	61.6	50.4	.123	.04	.079	.055
Do	1.59 p. m.	67.0	52.8	.135	.20	.102	.063
Do	3.02 p. m.	64.7	52.1	.144	.49	.115	.072
Do	4.06 p. m.	53.4	49.8	.141	.14	.063	.064
Do	5.10 p. m.	44.9	46.8	.133	.18	.086	.061
Do	6.20 p. m.	42.4	44.9	.149	.14	.080	.068
Do	7.28 p. m.	39.1	43.5	.140	.23	.079	.065
Do	8.32 p. m.	35.6	42.6	.135	.00	.066	.059
Do	9.35 p. m.	32.9	42.2	.144	.00	.062	.063
Do	10.38 p. m.	31.8	41.9	.145	.00	.060	.064
Do	11.41 p. m.	31.5	40.8	.130	.00	.058	.057
Oct. 28, 1922	12.47 a. m.	30.5	39.9	.123	.00	.060	.054
Do	1.53 a. m.	29.2	39.0	.122	.00	.045	.054
Do	2.56 a. m.	28.6	38.6	.119	.00	.052	.052
Do	3.58 a. m.	28.4	38.2	.110	.02	.047	.049
Do	5.02 a. m.	27.4	37.0	.095	.00	.038	.042
Do	6.06 a. m.	26.9	34.4	.075	.04	.038	.033
Do	7.14 a. m.	33.5	33.0	.046	.07	.021	.021
Do	8.21 a. m.	45.5	37.2	.032	1.30	.037	.020

[1] Rain.

TABLE 5.—*Evaporation as observed and as computed from formula 6 (p. 21) and pertinent meteorological data for outside conditions at Fort Collins, Colo., 1922–23*—Continued

Date	Time	Mean temperature		Mean difference in vapor pressure e_s-e_d	Mean ground wind velocity	Evaporation per 24 hours	
		Air	Water			Observed	Computed
		°*F.*	°*F.*	*Inch of mercury*	*Miles per hour*	*Inch*	*Inch*
Oct. 28, 1922	9.22 a. m.	53.0	41.9	0.040	0.32	0.047	0.019
Do	10.30 a. m.	58.0	46.9	.079	1.56	.132	.049
Do	11.38 a. m.	57.6	56.4	.207	1.01	.135	.116
Do	12.41 p. m.	60.0	59.4	.234	.89	.141	.127
Do	1.44 p. m.	63.8	55.4	.163	1.61	.183	.103
Do	2.46 p. m.	61.2	53.4	.152	2.01	.183	.103
Do	3.50 p. m.	59.5	51.6	.138	1.22	.126	.081
Do	4.55 p. m.	56.0	49.9	.137	.28	.093	.065
Aug. 16, 1923	12.46 p. m.	73.3	74.6	.310	.17	.110	.143
Do	1.56 p. m.	73.9	75.9	.370	.26	.139	.174
Do	3.02 p. m.	76.0	77.2	.402	.42	.160	.197
Do	4.08 p. m.	72.7	76.2	.404	.35	.244	.194
Do	5.13 p. m.	68.9	74.2	.382	.00	.150	.168
Do	6.27 p. m.	66.6	73.2	.305	.00	.135	.134
Do	7.40 p. m.	62.6	72.0	.272	.00	.129	.120
Do	8.45 p. m.	60.7	71.3	.273	.00	.129	.120
Do	9.49 p. m.	59.3	70.7	.267	.00	.133	.118
Do	10.52 p. m.	58.7	69.9	.260	.00	.134	.114
Do	11.58 p. m.	59.0	69.0	.235	.00	.128	.103
Aug. 17, 1923	1.04 a. m.	57.6	68.2	.237	.00	.122	.104
Do	2.14 a. m.	55.9	67.6	.250	.00	.119	.110
Do	3.22 a. m.	54.8	66.7	.243	.00	.123	.107
Do	4.33 a. m.	53.7	66.0	.243	.00	.115	.107
Do	5.43 a. m.	55.8	65.7	.216	.00	.107	.095
Do	6.52 a. m.	61.3	65.8	.170	.33	.056	.081
Do	8.02 a. m.	67.5	67.7	.160	.67	.054	.083
Do	9.09 a. m.	72.3	71.6	.230	.61	.076	.118
Do	10.16 a. m.	74.5	75.2	.334	.53	.128	.168
Do	11.21 a. m.	76.6	77.3	.409	.52	.159	.205
Do	12.38 p. m.	79.3	79.0	.445	.70	.208	.233
Do	1.54 p. m.	80.1	80.8	.498	.88	.250	.271
Do	3.03 p. m.	79.7	80.9	.478	.40	.232	.233
Do	4.09 p. m.	79.3	80.3	.411	.26	.232	.194
Do	5.12 p. m.	73.6	78.6	.444	1.96	.422	.298
Aug. 23, 1923	8.49 a. m.	66.7	67.4	.207	.43	.049	.102
Do	9.54 a. m.	68.9	71.1	.262	.43	.092	.129
Do	10.59 a. m.	69.3	73.0	.283	.36	.113	.136
Do	12.04 p. m.	72.5	75.1	.359	.45	.124	.177
Do	1.15 p. m.	73.0	77.4	.430	.59	.169	.219
Do	2.28 p. m.	70.7	75.8	.374	.00	.115	.164
Do	3.33 p. m.	71.3	74.1	.345	.06	.116	.154
Do	4.38 p. m.	76.0	73.5	.308	.00	.107	.136
Do	5.41 p. m.	67.9	72.6	.273	.00	.082	.120
Do	6.47 p. m.	62.0	71.5	.302	.00	.134	.133
Do	7.57 p. m.	57.3	70.4	.309	.00	.150	.136
Do	9.09 p. m.	57.4	69.5	.281	.00	.134	.124
Do	10.13 p. m.	55.6	68.5	.259	.00	.117	.114
Do	11.19 p. m.	54.2	67.6	.260	.00	.126	.114
Aug. 24, 1923	12.24 a. m.	53.2	66.9	.268	.00	.128	.118
Do	1.29 a. m.	51.7	66.0	.271	.00	.130	.119
Do	2.34 a. m.	50.6	65.0	.255	.00	.133	.112
Do	3.39 a. m.	50.7	64.0	.235	.00	.131	.103
Do	5.08 a. m.	51.9	63.1	.217	.00	.103	.096
Do	6.36 a. m.	55.9	62.8	.171	.00	.056	.075
Do	7.40 a. m.	62.5	64.3	.172	.00	.032	.076
Do	8.45 a. m.	68.5	67.9	.225	.05	.051	.100
Do	9.50 a. m.	74.0	72.5	.302	.18	.107	.139
Do	2.20 p. m.	67.1	73.2	.343	.04	.100	.153
Do	3.28 p. m.	72.6	73.0	.356	.00	.124	.157
Sept. 29, 1923	9.01 a. m.	52.0	52.6	.111	.33	.053	.053
Do	10.08 a. m.	59.2	57.4	.173	.66	.092	.090
Do	11.12 a. m.	63.5	61.6	.299	.74	.129	.157
Do	12.19 p. m.	65.6	63.8	.366	1.28	.176	.216
Do	1.26 p. m.	64.9	63.2	.340	.82	.144	.183
Do	2.31 p. m.	64.1	61.5	.311	2.20	.208	.218
Do	3.39 p. m.	63.4	60.0	.299	2.66	.223	.225
Do	4.43 p. m.	60.1	58.5	.277	.93	.149	.152
Sept. 30, 1923	1.33 p. m.	51.1	54.1	.063	.46	.036	.031
Do	2.30 p. m.	51.6	54.2	.063	.24	.030	.030
Do	3.37 p. m.	52.0	54.2	.073	.10	.031	.033
Do	4.57 p. m.	51.6	54.2	.073	.00	.035	.032
Oct. 4, 1923	9.05 a. m.	50.6	51.4	.038	.46	.025	.019
Do	10.09 a. m.	52.9	53.1	.058	.70	.033	.030
Do	11.14 a. m.	53.6	53.6	.069	.80	.023	.031

TABLE 5.—*Evaporation as observed and as computed from formula 6 (p. 21) and pertinent meteorological data for outside conditions at Fort Collins, Colo., 1922–23*—Continued

Date	Time	Mean temperature		Mean difference in vapor pressure e_s-e_d	Mean ground wind velocity	Evaporation per 24 hours	
		Air	Water			Observed	Computed
		°F.	°F.	*Inch of mercury*	*Miles per hour*	*Inch*	*Inch*
Oct. 4, 1923	12.24 p. m.	54.2	53.6	0.057	0.07	0.026	0.028
Do	1.33 p. m.	55.9	55.1	.070	.35	.035	.034
Do	2.36 p. m.	56.7	56.2	.096	.28	.039	.045
Do	3.42 p. m.	55.8	55.9	.099	.23	.038	.046
Do	4.47 p. m.	54.3	55.3	.082	.00	.019	.036
Nov. 13, 1923	10.28 a. m.	45.9	39.0	.079	.54	.040	.040
Do	11.20 a. m.	53.4	41.6	.106	.92	.076	.058
Do	12.27 p. m.	59.1	45.6	.147	.84	.091	.079
Do	1.34 p. m.	58.6	47.0	.161	.78	.094	.086
Do	2.38 p. m.	53.3	45.4	.160	.39	.078	.078
Do	3.40 p. m.	42.7	43.0	.136	.00	.050	.060
Do	4.45 p. m.	35.6	41.0	.108	.07	.046	.048
Do	5.56 p. m.	32.5	39.1	.094	.13	.044	.043
Do	7.08 p. m.	31.4	37.9	.084	.30	.042	.040
Do	8.14 p. m.	28.9	35.3	.111	.00	.026	.049
Do	9.19 p. m.	25.5	32.5	.098	.00	.023	.043
Do	10.20 p. m.	25.5	32.0	.056	.00	.021	.025
Nov. 14, 1923	10.26 a. m.	51.0	40.3	.087	.48	.056	.044
Do	11.30 a. m.	55.4	43.9	.125	.58	.080	.063
Do	12.31 p. m.	60.0	46.6	.166	.73	.082	.087
Do	1.35 p. m.	59.6	48.0	.179	.49	.081	.089
Do	2.38 p. m.	52.6	46.1	.165	.20	.064	.078
Do	3.38 p. m.	43.3	43.0	.136	.00	.046	.060
Do	4.40 p. m.	37.5	41.0	.120	.06	.050	.054

Mean 24-hour evaporation in 1922 as observed, 0.1314 inch.
Mean 24-hour evaporation in 1922 as computed, 0.1250 inch.
Mean 24-hour evaporation in 1923 as observed, 0.1039 inch.
Mean 24-hour evaporation in 1923 as computed, 0.1112 inch.

Under outside conditions the wind is variable; gusts are followed by periods of calm, while in the laboratory the wind may be kept constant. Since in the formula the wind factor and the difference in vapor pressure are both linear functions, it might seem that wind variations would have little effect on evaporation. However, the product of two linear functions is a function of higher degree. The anemometer registers the total wind movement without regard to the rates, and while the mean wind may be taken as a true mean, nevertheless, unless the difference in vapor pressure remains constant, the result obtained by using the mean wind in the formula will not be the same as the result obtained by taking the mean of the individual evaporation determinations as computed by using the various component wind velocities. Fortunately, the vapor-pressure difference varies between narrow limits during hourly periods, so that the difference resulting from the method of computing is probably not great.

Although the vapor pressure changed but little from hour to hour, there was pronounced oscillation in the wet-bulb readings which showed that the vapor pressure of the outside air was varying constantly. This was not observed in the laboratory. Since the mean difference in vapor pressure was based on the temperature of the water and the psychrometer readings taken at the beginning and end of each test, any unusual variation in the vapor pressure during the period of the test would pass unnoticed and was probably the cause of some of the inconsistencies evident in the data. Nevertheless, the general agreement between the observed and computed evaporation indicates that the formula derived from experiments under controlled conditions in the laboratory is applicable to the natural conditions outside.

OBSERVATIONS ON A HEATED WATER SURFACE IN WINTER

In a study of the evaporation from the Great Lakes (*14, p. 123, 134–137*) the inflow and outflow records indicated that evaporation was greater in winter than in summer, and the question was raised as to the evaporation from an open water surface in cold weather. A study of this sort would make it possible to test evaporation formula 6 under extreme conditions, and, consequently, a series of observations was started in January, 1927, to determine the evaporation under low temperatures.

The apparatus for these tests was installed in the tank used during the observations on evaporation under fully exposed conditions outside. This tank, which was 3 feet square and 18 inches deep, was sunk in the ground to within about 1½ inches of the top, and the water was kept about the same distance from the top. The standard apparatus was used except that evaporation was measured by a micrometer hook gage (fig. 5) reading to thousandths of an inch, attached in the stilling well on the outside of the tank.

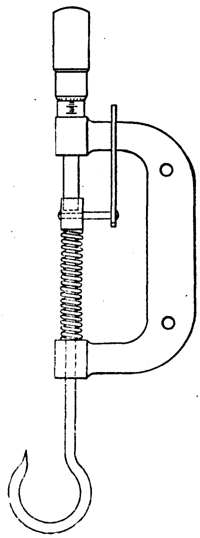


FIGURE 5.—Micrometer hook gage, 8½ inches long, reading to one one-thousandth of an inch.

To keep the water in the tank from freezing, an electric heating element consisting of 18 feet of 22-gage nichrome wire fastened to a wooden frame was installed in the bottom of the tank. The terminals of the heating element were at first attached directly to the 110-volt lighting circuit, but it was found that this raised the temperature too high and also caused electrolysis of the water. Additional resistance, consisting of 18 feet more of nichrome wire exposed to the air, was therefore placed in series in the circuit to reduce the current. This arrangement kept the water surface from freezing even in zero weather and did not heat the water unduly at ordinary winter temperatures. However, the stilling well which was outside the tank occasionally froze over.

On account of the low temperature expected, the thermometers used for the air, water, and wet and dry bulb temperatures, were graduated to include temperatures below zero. These thermometers were 12 inches long, and the smallest graduation was 1°. Comparison of these thermometers with a standard thermometer calibrated by the United States Bureau of Standards showed that the maximum deviation was 0.5°. The water and air thermometers were held in place by adjustable clamps so that the bulb of the water thermometer was just beneath the surface, and the bulb of the air thermometer approximately 1 inch above it. The aspiration psychrometer, similar to the one shown in Plate 3, A, was so arranged that the air was drawn from the center of the tank at a point about 1 inch above the water surface.

A standard Robinson anemometer was used for measuring the wind. It was so placed that the centers of the cups were 17 inches above the ground. The indicated velocity was reduced to the ground velocity by the use of a comparison diagram.

A rain gage of the Weather Bureau type was maintained near the tank. In case of heavy snowfall with wind, this gage did not prove satisfactory because all of the snow that fell into the water in the evaporation tank remained there, whereas much of the snow blew out of the rain gage; consequently evaporation records for periods of heavy snowfall had to be discarded.

In making these tests, the readings were taken at 8 a. m. and 5 p. m. They consisted of the air and water and the wet and dry bulb temperatures, wind movement, time, precipitation, and evaporation loss.

The results of the observations and the computed evaporation obtained by substituting the observed data in formula 6, are given in Table 6. The results shown are the weighted means for the 24-hour periods, but for reasons stated on page 26 the substitution of the mean data in the formula will not give the computed evaporation recorded in the table. The table shows that except for periods of heavy snowfall there is a fairly close agreement between the observed and the computed evaporation, and that the mean values for the entire period, excepting days of heavy snowfall, are almost identical. During the period of the observations the temperature of the air varied between −3.6° and 53° F., but the temperature of the water varied little. Except for the observations taken before adding resistance in the circuit of the heating element, the water temperature averaged about 50°. The mean evaporation under these conditions, as a comparison with Table 5 will show, was approximately equal to the August and September rate and indicates that large bodies of open water probably have a high evaporation loss in winter.

EVAPORATION FROM ICE UNDER CONTROLLED CONDITIONS IN THE LABORATORY

Measurements were made on the evaporation from ice in the laboratory without wind in January and February, 1926, and under outside conditions in 1927, but representative results were not obtained because the weather was so warm that the ice melted during the day. However, the unusually cold weather of 1928–29 made it possible to conduct a long series of observations on the evaporation from ice under controlled conditions in the laboratory.

These observations were made on a pan of ice 1 inch thick and 17½ inches in diameter, and the evaporation loss was determined by weighing on a beam balance sensitive to one-half gram. Accurate thermometers graduated into half degrees were used for taking the temperatures of air and ice, and the wet and dry bulb temperatures. The ice thermometer was placed with its bulb immersed in a small bottle filled with alcohol and frozen in the ice in the center of the pan. The air thermometer was so placed that its bulb was about 1 inch above the surface of the ice. Both thermometers were suspended from the beam of the balance. A portable aspiration psychrometer (fig. 6) was used to determine the vapor pressure of the air. It was so installed that the air was drawn from a point near the center of the pan about 1 inch above the surface of the ice.

TABLE 6.—*Evaporation from a heated-water surface under outside conditions in winter, as observed and as computed from formula 6, and pertinent meteorological data at Fort Collins, Colo., 1927*

[Tank, 3 by 3 feet, 18 inches deep]

Date	Precipitation	Mean temperature		Mean difference in vapor pressure, e_s-e_d	Mean ground wind velocity	Evaporation per 24 hours	
		Air	Water			Observed	Computed
	Inch	*°F.*	*°F.*	*Inch of mercury*	*Miles per hour*	*Inch*	*Inch*
Jan. 25		33.4	66.0	0.658	1.07	0.392	0.398
Jan. 26		29.7	79.2	.909	.81	.505	.484
Jan. 27		29.9	55.2	.329	1.98	.202	.211
Jan. 28		36.4	48.8	.231	4.93	.259	.236
Jan. 29		38.1	46.7	.235	8.04	.277	.325
Jan. 30		34.5	45.0	.244	6.06	.228	.288
Jan. 31		26.1	44.2	.224	.85	.112	.122
Feb. 1		31.7	47.8	.238	2.16	.161	.165
Feb. 2		31.3	51.1	.265	.54	.134	.134
Feb. 3		36.1	54.0	.305	.66	.137	.158
Feb. 4		36.7	55.0	.311	1.20	.160	.181
Feb. 5		37.4	54.5	.302	1.20	.186	.176
Feb. 6		40.4	52.9	.299	1.58	.184	.186
Feb. 7		32.9	50.3	.266	1.88	.172	.175
Feb. 8	0.127	24.4	48.3	.240	1.50	.098	.148
Feb. 9	.014	7.0	44.4	.232	.35	.139	.112
Feb. 10		13.3	44.6	.228	.34	.120	.109
Feb. 11		19.7	47.8	.232	.48	.117	.115
Feb. 12		30.5	49.0	.225	1.48	.155	.138
Feb. 13	.005	32.2	50.4	.225	.99	.127	.126
Feb. 14		27.4	48.4	.220	.89	.126	.120
Feb. 15		36.5	51.7	.244	2.75	.180	.187
Feb. 16		39.9	52.7	.275	2.19	.213	.194
Feb. 17	.005	37.2	53.9	.296	2.08	.154	.202
Feb. 18		23.5	48.6	.225	1.15	.141	.129
Feb. 19		41.7	52.7	.294	3.07	.196	.238
Feb. 20		45.6	56.4	.342	1.65	.197	.216
Feb. 21	Trace.	45.6	57.4	.324	3.79	.273	.284
Feb. 22		39.3	53.8	.277	3.88	.272	.249
Feb. 23		41.8	52.6	.312	4.73	.270	.314
Feb. 24		41.4	52.3	.307	.57	.326	.368
Feb. 25		32.5	50.7	.280	1.79	.196	.183
Feb. 26		37.9	55.7	.319	.70	.165	.165
Feb. 27	.123	36.4	56.2	.283	1.17	.130	.164
Mar. 1	.002	21.5	50.4	.280	.61	.143	.145
Mar. 2		31.2	53.2	.282	.34	.139	.136
Mar. 3		36.3	57.1	.307	.35	.142	.148
Mar. 4	.002	39.5	58.5	.296	.95	.170	.163
Mar. 5	.060	38.5	57.6	.278	1.44	.161	.168
Mar. 6	.004	39.0	55.3	.244	.84	.142	.132
Mar. 7		39.5	53.4	.257	2.21	.182	.180
Mar. 8		41.1	58.2	.320	.93	.187	.177
Mar. 9		45.9	59.6	.327	1.44	.232	.197
Mar. 12		32.7	45.6	.208	7.84	.257	.281
Mar. 13		46.1	54.0	.278	1.91	.166	.187
Mar. 14		46.6	59.1	.317	1.02	.185	.154
Mar. 15		48.2	59.9	.361	3.51	.312	.222
Mar. 16	.002	36.1	54.6	.324	3.94	.305	.292
Mar. 17		34.1	52.4	.318	.83	.154	.171
Mar. 18		34.0	53.2	.294	1.00	.220	.191
Mar. 20	.032	22.1	48.7	.264	1.26	.153	.156
Mar. 21		27.8	50.2	.272	.47	.144	.147
Mean						.1942	.1962

Feb. 28, and Mar. 10, 11, 19, and 22 excluded because of heavy snowfall.

The readings, except for evaporation, were taken at 8 a. m., 1 p. m., and 6 p. m. The evaporation was measured at 8 a. m. only, because in previous attempts to measure the evaporation from ice, water accumulated on the surface of the pan during the day which made it difficult to weight the pan accurately on account of the tendency of the pan to tilt and spill the water. In addition, the longer period between the observations of the evaporation loss reduced the error in the result because the decrease in weight was greater.

The first observations were made under still-air conditions. The results of these observations and the computed evaporation obtained by substituting the observed data in formula 6 where $W=0$, are shown in Table 7. The values shown are the weighted means, and as previously explained (p. 26) the computed evaporation can not be correctly determined by substituting the mean data in the formula. A comparison of the observed and computed evaporation does not show

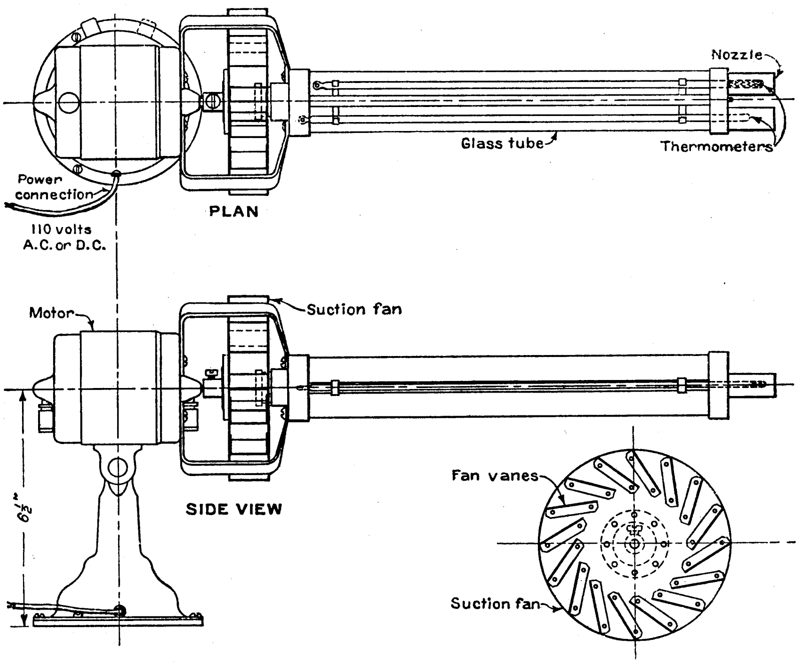
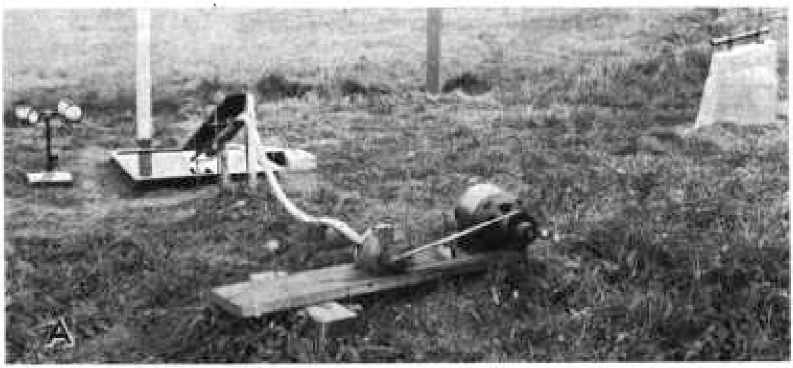
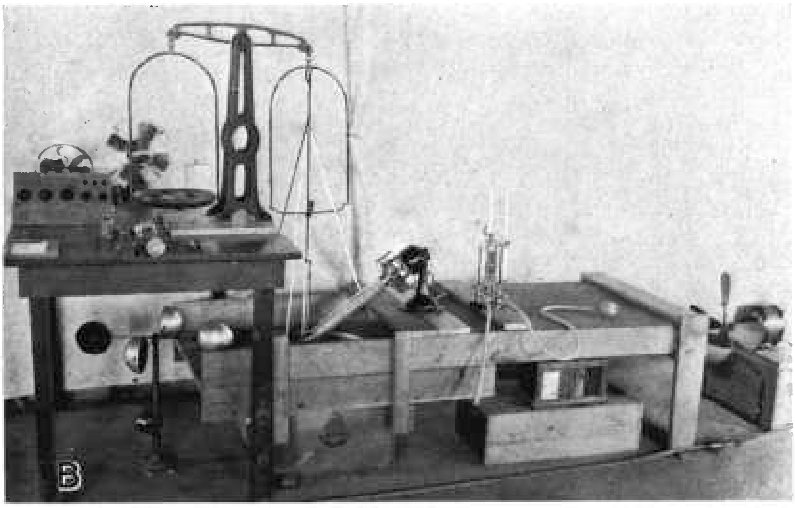


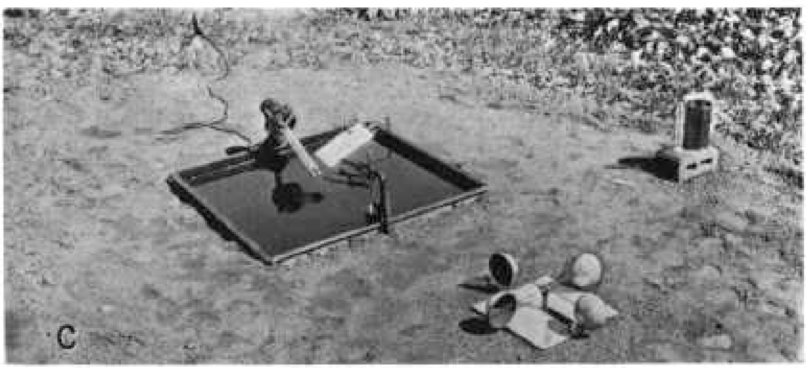
FIGURE 6.—Motor-driven Assman psychrometer used in determining the vapor pressure of the air

very satisfactory agreement, but the differences in vapor pressures are quite small and therefore a small error in either vapor pressure will cause a relatively large error in the difference. The tendency is for the computed values to be too large. This is attributed to the fact that the air in the laboratory is very quiet, while there is a definite movement of the air outside even though the anemometer does not register any wind. This same phenomenon was noted (p. 21) when the formula was developed.

An attempt was made to compute the evaporation by formula 3 which was derived from still-air observations in the laboratory, but it gave results that were as much too small as those of formula 6 were too large, probably because the air was not so quiet as it was for the still-air observations in the calibration tank.







A, Apparatus for making evaporation observations under outside conditions; B, apparatus for conducting controlled-wind experiments on evaporation from ice (a portion of the wind tunnel cover has been removed to show the ice pan); C, equipment as installed for determining the effect of altitude on evaporation

TABLE 7.—*Evaporation from ice in still air in the laboratory, as observed and as computed from formula 6, and pertinent meteorological data at Fort Collins, Colo., 1928–29*

Date	Mean temperature		Mean vapor pressure difference $e_s - e_d$	Evaporation per 24 hours	
	Air	Ice		Observed	Computed
	° *F.*	° *F.*	*Inch of mercury*	*Inch*	*Inch*
Dec. 7, 1928	24.1	[1] 25.1	0.036	0.0088	0.0157
Dec. 8, 1928	26.1	25.8	.028	.0080	.0122
Dec. 9, 1928	26.2	26.5	.036	.0082	.0162
Dec. 10, 1928	26.2	25.6	.032	.0082	.0138
Dec. 11, 1928	25.2	25.2	.029	.0086	.0127
Dec. 12, 1928	28.4	[2] 27.5	.018	.0032	.0078
Dec. 13, 1928	29.4	29.0	.023	.0291	.0099
Dec. 14, 1928	27.0	[3] 27.6	.021	.0067	.0093
Dec. 15, 1923	28.1	27.6	.011	.0061	.0050
Dec. 16, 1928	25.6	25.1	.017	.0095	.0072
Dec. 17, 1928	25.6	24.3	.013	.0087	.0057
Dec. 18, 1928	24.7	24.1	.012	.0087	.0053
Dec. 19, 1928	23.8	22.7	.029	.0093	.0126
Dec. 20, 1928	23.2	22.0	.018	.0086	.0080
Dec. 21, 1928	26.7	25.6	.020	.0040	.0088
Dec. 22, 1928	28.8	28.0	.030	.0077	.0130
Dec. 23, 1928	28.7	27.9	.008	.0066	.0034
Dec. 24, 1928	28.6	28.1	.006	.0071	.0028
Dec. 25, 1928	28.2	27.7	.025	.0072	.0109
Dec. 27, 1928 [4]	32.3	32.0	.049	.0083	.0212
Dec. 28, 1928 [5]	34.1	32.3	.032	.0044	.0142
Jan. 2, 1929	27.1	26.7	.030	.0072	.0125
Jan. 3, 1929	29.9	28.9	.030	.0058	.0132
Jan. 4, 1929	28.8	28.2	.021	.0050	.0093
Jan. 5, 1929 [6]	26.0	25.4	.029	.0100	.0125
Jan. 6, 1929	23.7	23.1	.022	.0087	.0099
Jan. 7, 1929	25.6	24.9	.017	.0052	.0074
Jan. 8, 1929	27.8	27.1	.028	.0069	.0121
Jan. 9, 1929	30.3	29.6	.029	.0040	.0124
Jan. 10, 1929	30.3	29.0	.048	.0091	.0213
Jan. 11, 1929	30.7	29.7	.033	.0065	.0146
Jan. 12, 1929	31.7	30.4	.043	.0074	.0188
Mean				.0079	.0112

[1] Ice thermometer frozen in ice.
[2] Put ice thermometer in bottle containing glycerine ink.
[3] Ink frozen. Denatured alcohol was put in bottle.
[4] Ice wet.
[5] Observations discontinued because of warm weather.
[6] Put ⅛-inch brass bars under ice pan to ventilate bottom.

To measure the evaporation from ice under more nearly normal conditions, a small electric fan was installed in the laboratory at such a distance from the pan that the air movement would not register on a Robinson anemometer placed near the pan. The results of these observations are given in Table 8. The table was prepared in the same manner as Table 7, and the same restrictions apply to it. A fairly close agreement between the observed and computed evaporation indicates that slight changes in the air movement have a very appreciable effect when the wind velocity is so low that it does not register on the anemometer.

A series of tests was also made on the effect of wind on the evaporation from ice. For these observations the ice pan was installed in a wind tunnel, as shown in Plate 3, B. This tunnel was 5 feet long, 21 inches wide, and 4 inches deep. The cover for the end of the tank, which extended to the anemometer cups, has been removed to show the position of the pan. The largest fan used is shown in place in Plate 3, B, and the two smaller fans on the table in the background.

The anemometer was so placed that the cups cleared the floor of the tunnel by about one-half inch. The same thermometers and psychrometers were used as in the previous tests.

TABLE 8.—*Evaporation from ice under slight wind* [1] *in the laboratory, as observed and as computed from formula 6, and pertinent meteorological data at Fort Collins, Colo., 1929*

Date	Mean temperature		Mean vapor pressure difference e_s-e_d	Evaporation per 24 hours	
	Air	Ice		Observed	Computed
	° F.	° F.	Inch of mercury	Inch	Inch
Jan. 13	34.2	31.4	0.042	0.0138	0.0182
Jan. 17	[2] 34.0	[2] 31.9	[2] .042	[2] .0139	[2] .0184
Jan. 18	30.7	29.9	.034	.0146	.0150
Jan. 19	29.6	28.1	.048	.0149	.0209
Jan. 20	23.1	21.9	.037	.0137	.0164
Jan. 21	22.4	21.5	.025	.0097	.0109
Jan. 22	26.7	[3] 25.2	.022	.0085	.0098
Jan. 23	25.5	24.3	.029	.0145	.0128
Jan. 24	19.0	18.3	.018	.0128	.0070
Jan. 25	17.7	16.6	.019	.0105	.0083
Jan. 26	21.8	20.2	.015	.0070	.0066
Jan. 27	24.8	23.7	.019	.0087	.0083
Mean				.0119	.0127

[1] Electric fan placed at such a distance that wind movement did not register on an anemometer placed near the pan.
[2] Mean of 4-day period because ice melted.
[3] Water was added to alcohol.

The evaporation loss was measured only at 8 a. m., but the other readings were taken in addition at 1 p. m. and 6 p. m. While weighing the pan it was necessary to shut off the fan, but the other observations were taken while the fan was running.

The results of these observations and the evaporation as computed by substituting the observed data in formula 6 are given in Table 9 which is subject to the same restrictions (p. 30) as Tables 7 and 8. Here it will be noted that the observed evaporation exceeded the computed evaporation. As previously explained, since the vapor pressures of the air and ice are nearly equal at low temperatures, small errors in the determination of the vapor pressures of the air or ice cause relatively large errors in the differences in vapor pressure, and if either contains a systematic error the computed results will be in error by a much larger amount. For example, under the conditions existing during these observations, an error of 10 per cent in the vapor pressure of the air will cause an error of 30 per cent in the computed evaporation. In view of the fact that there is some uncertainty as to vapor pressures at temperatures below freezing (*23, p. 9–10, 15–56*), and since reliable readings are hard to obtain with the aspiration psychrometer when the water on the wet bulb is freezing, an error of 10 per cent in the vapor pressure of either the air or the ice is quite possible, and consequently very reliable results are not to be expected in computing the evaporation from ice.

TABLE 9.—*Evaporation from ice under controlled wind in the laboratory, as observed and as computed from formula 6, and pertinent meteorological data at Fort Collins, Colo.*

Date	Mean temperature		Mean vapor pressure difference, e_s-e_d	Mean wind velocity	Evaporation per 24 hours	
	Air	Ice			Observed	Computed
	° F.	° F.	*Inch of mercury*	*Miles per hour*	*Inch*	*Inch*
Jan. 30, 1929	25.5	23.9	0.018	4.91	0.0296	0.0181
Jan. 31, 1929	28.4	25.4	.039	4.92	.0568	.0395
Feb. 1, 1929	26.4	23.8	.032	[1] 5.08	.0506	.0331
Feb. 2, 1929	29.9	28.3	.034	[2] 5.37	.0482	.0361
Feb. 3, 1929	30.4	28.9	.029	5.54	.0434	.0321
Feb. 5, 1929 [3]	30.7	30.2	.043	[4] 5.44	.0598	.0467
Feb. 6, 1929	27.0	22.7	.029	[5] 5.40	.0398	.0308
Feb. 7, 1929	19.1	17.6	.029	5.19	.0428	.0307
Feb. 8, 1929	15.0	13.8	.028	[6] 2.95	.0288	.0218
Feb. 9, 1929	13.4	12.6	.023	2.79	.0230	.0175
Feb. 10, 1929	16.4	15.6	.017	2.98	.0182	.0132
Feb. 12, 1929 [3]	21.3	20.3	.020	2.42	.0203	.0147
Feb. 13, 1929	21.7	20.3	.023	[7] 5.06	.0325	.0238
Feb. 14, 1929	23.7	22.7	.023	6.00	.0336	.0262
Feb. 15, 1929	22.6	21.6	.013	6.21	.0344	.0161
Feb. 16, 1929	23.2	22.2	.024	5.80	.0370	.0273
Feb. 17, 1929	30.1	29.0	.041	5.87	.0499	.0459
Feb. 19, 1929 [3]	21.9	20.4	.035	[8] 15.94	.1040	.0811
Feb. 20, 1929	22.6	20.8	.026	15.70	.0839	.0596
Feb. 21, 1929	29.4	27.3	.051	14.77	.1423	.1108
Feb. 22, 1929	26.8	25.9	.038	14.25	.1080	.0795
Feb. 23, 1929	27.4	25.7	.033	14.21	.0943	.0702
Feb. 24, 1929	32.8	30.0	[9] .032	14.11	.1070	.0674
Feb. 26, 1929 [3]	30.7	29.4	.040	[10] 10.52	.1150	.0662
Feb. 27, 1929	29.8	27.0	.041	10.49	.0960	.0682
Feb. 28, 1929	28.4	26.2	.046	10.27	.1094	.0762
Mar. 1, 1929	26.8	25.3	.048	10.20	.1045	.0789
Mar. 2, 1929	32.5	30.4	.053	9.82	.1007	.0838
Mar. 3, 1929	33.2	31.9	.056	9.59	.1145	.0887
Mean					.0665	.0484

[1] Anemometer was raised one-fourth inch.
[2] Anemometer was raised one-fourth inch more.
[3] Pan refilled.
[4] Covered 16 inches more of top of wind flume and lowered anemometer one-half inch.
[5] Anemometer raised one-fourth inch.
[6] Fan speed reduced.
[7] Changed from 8-inch fan to 6-inch fan.
[8] Changed to 16-inch fan.
[9] Based on 1 estimated value.
[10] Placed screen to reduce wind and set fan back 9 inches.

During the latter part of the series the aspiration psychrometer was checked against an Alluard dew-point hygrometer to determine, if possible, whether the aspiration psychrometer was operating satisfactorily. Some difficulty was encountered in taking the readings of the dew point on account of the slowness with which dew deposited on the hygrometer. However, the means of six determinations were found to differ by less than 2½ per cent, and the maximum deviation was 9 per cent.

While the evaporation observations were being made, a pronounced roughening of the surface of the ice due to the wind was observed. This increased the area of the evaporating surface and may explain why the observed evaporation was greater than the computed value.

The observed evaporation from ice, as shown in the tables, varied between 0.0032 and 0.1423 inch per 24 hours, depending on the difference in vapor pressure and the wind velocity. The maximum rate occurred when the wind was blowing 14.77 miles per hour (Table 9), and the minimum rate when there was no wind. (Table 7.) This indicates that the loss from ice is considerable when a strong wind is blowing. Fitzgerald (*11, p. 590, 611*) working in Boston in 1886 on the evaporation from ice in pans 14.85 inches in diameter, recorded a loss of 0.20 inch per 24 hours on February 24, 1886, when the wind velocity was 12 miles per hour at the elevation of the pans. It is probable that even higher rates occur in Colorado under outside conditions.

EFFECT OF ALTITUDE ON EVAPORATION

In deriving a general formula for the evaporation loss, one of the factors to be considered is the effect of altitude or barometric pressure. Experimenters have held different views as to the influence of altitude when the other factors remain the same. Dalton, as reported by Preston (*28, p. 426–427*), noted when measuring the vapor pressure of gases that the rate of evaporation decreased as the pressure of the air or other gas increased. Fitzgerald (*11*) carried on similar experiments and concluded that, in general, the rate of evaporation was in inverse proportion to the pressure of the atmosphere. Meyer (*26, p. 192–194*) held, however, that the effect of barometric pressure is taken care of by the change in the difference in vapor pressure, due to the altitude. Nevertheless, for any definite difference in vapor pressure, the higher the altitude the smaller the number of molecules there will be in the atmosphere to obstruct the passage of the vapor from the water surface to the air.

Since both the temperature and the vapor pressure of the air change when the atmospheric pressure is decreased, direct observations on the effect of altitude on the evaporation, while the other conditions remain the same, have been difficult to obtain. Observations made by Fortier (*13, p. 305*) on Mount Whitney at elevations of between 4,515 and 14,502 feet to determine the effect of altitude on evaporation are not conclusive. These show that, in general, evaporation decreases, but they show also that temperature decreases as altitude increases, and since Fortier's results indicate that evaporation followed temperature more closely than it followed altitude, the question arises as to whether it was altitude or temperature variations that caused variations in the evaporation.

PROCEDURE

To overcome the difficulties heretofore encountered, a series of observations was made in 1927 in which the problem was attacked in a different manner.

Formula 6 is general in its application, in so far as the effects of vapor pressure and wind is concerned, as is shown by comparison with the results of tests under a wide range of conditions as already reported and with the results of nearly 2,000 observations on each of three different types of tanks extending over a period of three years as hereafter described. Formula 6, however, applies only to conditions at Fort Collins, Colo., so far as the effect of altitude is concerned. If the wind velocity and difference in vapor pressure are measured at a station of different elevation and these values substituted in the formula, the resulting computed evaporation will be the evaporation that would have occurred at Fort Collins under all the conditions observed at the second station, and the difference between this computed evaporation and the evaporation actually observed at the second station is evidently that due to the difference in altitude. It follows, then, that the difference between the observed evaporation at any point and the evaporation at Fort Collins as computed by the formula for conditions similar except as to altitude, is the evaporation due to the difference in altitude between the two points.

Two series of observations were made in 1927 at Victor, Colo., and Fort Calhoun, Nebr., at elevations of 10,089 and 1,160 feet, respectively, above sea level. The results of these observations indicated that this method of solving the problem would give satisfactory results, and during 1928 observations were made at altitudes extending over a wider range. These were made at Imperial, Calif. (elevation 68 feet below sea level); Lake Tahoe, Calif. (6,300 feet); Logan, Utah (4,778 feet); and Pikes Peak, Colo. (14,109 feet). After completing these tests the apparatus was set up at Fort Collins, and readings were taken to determine how closely the computed results agreed with the results observed at Fort Collins.

EQUIPMENT

The apparatus used in making these tests consisted of an evaporation tank, thermometers for determining the temperature of the water surface and of the air 1 inch above it, a mercurial barometer, a psychrometer, an anemometer, a micrometer hook gauge for measuring the evaporation, and a rain gauge. The evaporation tank which was 3 feet square and 10 inches deep was used previously in making observations under controlled conditions in the laboratory. The tank was sunk in the ground to within about 1 inch of the top, and the water level was kept at about the same distance from the top. A canvas cover was provided to shelter the tank from rain, but it was used only during the observations at the summit of Pikes Peak. The shelter was supported by a wire frame in such a manner that the movement of the air over the tank should not be interfered with. (Pl. 6, B.) Before each series of tests the inside of the tank was given a coat of asphaltum paint so as to maintain uniform conditions in all of the tests. However, as is explained later, a change in the brand of paint used during two sets of observations introduced errors in the results that had to be corrected by making comparative tests using both kinds of paint.

The waters used in the evaporation tank were obtained from local sources and in most cases were quite soft, but the water used at Imperial, Calif., was noticeably hard. An analysis of this water showed total solids, including silt in suspension, of 455 parts per million, whereas that of the water from Victor, Colo., showed total solids of only 61 parts per million. Samples of the other waters were not tested because they had been permitted to stand for some time before being submitted for analysis, and testing was then useless because the waters had dissolved appreciable quantities of the glass from the containers.

The thermometers used were 12 inches long and were graduated into half degrees. These thermometers were compared with a standard thermometer calibrated by the United States Bureau of Standards and with one exception were found to be sufficiently accurate. As the calibration was made after some of the tests had been completed, it was necessary to correct the results obtained with that thermometer.

Where 110-volt electric current was available the portable aspiration psychrometer (fig. 6) was driven by an electric motor; otherwise the psychrometer fan was driven by a crank operating a train of gears. The results from both methods were checked against those obtained with a large aspiration psychrometer, similar to the one compared with the Alluard dew-point hygrometer (p. 33). The results were almost identical.

On account of the wide range of barometric pressures encountered, two barometers were required. One reading down to 20 inches of mercury was used in most of the tests, but for the observations on Pikes Peak a special barometer reading to 14 inches was necessary. Both were compared with standard barometers, and the errors were found to be negligible. The observations at Victor, Colo. (elevation, 10,089 feet), were made before the special high-altitude barometer was obtained, and for these two aneroid barometers were used. It was found, however, that these instruments were not sensitive at this altitude, and it was necessary to compute the barometric pressure from the known altitude of the point and the barometer reading at Fort Collins, Colo. Owing to the fluctuation of barometer readings with weather conditions, the mean barometer reading as computed from the altitude may differ slightly from the true mean reading for the period.

The wind velocities were determined by a Robinson anemometer. Since the ground velocity was desired, the anemometer was set in a pit so that the bottoms of the cups were about 1 inch above the ground surface. The anemometer was compared with a Robinson anemometer calibrated by the Bureau of Standards. Since the two instruments did not agree, a comparison diagram was prepared from which the true wind velocity could be read.

The micrometer hook gage (fig. 5) was attached to a standard bolted to the side of the evaporation tank. The water level at the center of the evaporation tank was transmitted through a pipe to a stilling well in which the level was read with the hook gage. The water level at the center of the evaporation tank was measured in order to eliminate the effect of the wind in tilting the water surface.

A special small-sized rain gage was used for measuring the precipitation. This was compared with the standard Weather Bureau type of rain gage at Fort Collins, and although the gages agreed quite closely as a rule, occasionally there was considerable variation. Periods of heavy rain were excluded from the records, and since errors in measuring light precipitation would have relatively little effect on the measured evaporation, the occasional errors in the rain gage probably had little influence on the results.

Each series of observations extended over a period ranging from eight days to two weeks, during which readings were taken every three hours, except between midnight and 6 a. m. when no intermediate readings were taken, since sudden changes in temperature and vapor pressure seldom occurred at that time.

In locating the equipment, care was taken to choose a position as free as possible from local obstructions, but at Victor, Colo., and Lake Tahoe, Calif., the topography did not permit selecting an ideal location. The apparatus and its location with respect to the topographic features are shown for each installation in Plates 3, C to 6, B, inclusive.

Environs of installation for determining the effect of altitude on evaporation: A, Victor, Colo.; B, Fort Calhoun, Nebr.

Environs of installation for determining the effect of altitude on evaporation: A, Imperial, Calif.; B, Lake Tahoe, Calif.; C, Logan, Utah

A, Equipment (canvas shelter removed) and environs of installation for determining the effect of altitude on evaporation at Pikes Peak. Colo.; B, canvas shelter for equipment at Pikes Peak, Colo.

OBSERVATIONS

The results of the observations at the different locations are given in Table 10, which shows for each day the precipitation; the mean barometer reading reduced to 32° F.; the weighted mean of the temperature of the air and water, of the ground wind velocity, and of the difference in vapor pressure; the observed evaporation in inches per 24 hours; the total computed evaporation in inches per 24 hours, obtained by substituting the observed data for each period in evaporation formula 6; and the ratio of the observed evaporation to the computed evaporation.

Since the computed evaporation for each day was obtained by substituting in formula 6 the observed data for that day, the mean results for a series (Table 12) will not be the same as those which would be arrived at by substituting in the formula the means of the observed data for that series.

TABLE 10.—*Influential meteorological factors, and evaporation as observed and as computed from formula 6, at stations of different altitudes*

VICTOR, COLO. (ELEVATION, 10,089 FEET)

Date	Precipitation	Mean barometer [1] reading	Mean temperature: Air	Mean temperature: Water	Mean ground wind velocity	Mean vapor pressure difference, e_s-e_d	Evaporation: Observed per 24 hours	Evaporation: Computed per 24 hours	Evaporation: Ratio observed to computed
	Inch	*Inches of mercury*	*° F.*	*° F.*	*Miles per hour*	*Inch of mercury*	*Inch*	*Inch*	
Aug. 14, 1927	--------	(2)	55.8	57.2	3.46	0.222	0.229	0.198	1.156
Aug. 15, 1927	--------	(2)	52.2	55.0	4.58	.177	.187	.168	1.112
Aug. 16, 1927	--------	(2)	53.6	53.9	3.04	.204	.189	.166	1.139
Aug. 17, 1927	0.040	(2)	47.2	52.8	2.32	.170	.106	.138	.770
Aug. 18, 1927	--------	(2)	50.1	56.4	2.54	.210	.179	.177	1.012
Aug. 19, 1927	.006	(2)	49.8	55.7	3.69	.176	.170	.165	1.031
Aug. 20, 1927	.594	(2)	48.6	53.4	2.41	.148	.127	.108	1.175
Aug. 21, 1927	.086	(2)	46.5	55.2	2.46	.181	[3] .077	[3] .098	.786

FORT CALHOUN, NEBR. (ELEVATION, 1,160 FEET)

Date	Precipitation	Mean barometer reading	Air	Water	Mean ground wind velocity	Vapor pressure difference	Observed	Computed	Ratio
Sept. 14, 1927	--------	28.51	82.6	78.8	2.33	0.345	0.243	0.253	0.960
Sept. 15, 1927	--------	28.65	82.8	80.5	1.43	.319	.191	.206	.928
Sept. 16, 1927	0.024	28.80	77.9	79.2	1.35	.271	.132	.162	.817
Sept. 17, 1927	--------	28.72	79.5	81.6	.67	.286	.125	.152	.823
Sept. 18, 1927	.508	28.73	69.7	75.0	2.14	.418	.299	.290	1.031
Sept. 19, 1927	--------	28.88	55.9	63.1	1.05	.332	.176	.197	.894
Sept. 20, 1927	--------	28.82	52.7	59.6	1.60	.274	.179	.177	1.012
Sept. 21, 1927	--------	28.93	48.8	55.9	.89	.224	.122	.126	.968
Sept. 22, 1927	--------	28.90	54.2	57.2	.67	.235	.103	.125	.824

IMPERIAL, CALIF. (ELEVATION, −68 FEET)

Date	Precipitation	Mean barometer reading	Air	Water	Mean ground wind velocity	Vapor pressure difference	Observed	Computed	Ratio
May 15, 1928	--------	29.77	75.8	70.3	6.57	0.509	0.552	0.605	0.912
May 16, 1928	--------	29.86	70.3	68.3	2.80	.401	.354	.352	1.005
May 17 1928	--------	29.89	76.2	77.6	1.04	.562	.263	.328	.803
May 18 1928	--------	29.92	78.7	79.3	1.32	.594	.337	.376	.897
May 19 1928	--------	29.94	81.8	79.0	1.72	.627	.368	.422	.872
May 20 1928	--------	29.94	80.7	78.9	1.70	.641	.386	.444	.870
May 21, 1928	--------	29.88	81.5	79.3	1.52	.631	.371	.448	.859
May 22, 1928	--------	29.84	83.4	79.1	1.70	.712	.420	.466	.901
May 23, 1928	--------	29.84	84.3	79.0	1.20	.653	.328	.385	.852
May 24, 1928	--------	29.86	83.6	82.0	1.26	.701	.349	.423	.825
May 25, 1928	--------	29.87	86.0	82.3	1.48	.722	.403	.454	.888
May 26, 1928	--------	29.86	86.2	82.2	1.40	.757	.411	.478	.860
May 27, 1928	--------	29.81	89.6	81.9	1.78	.708	.449	.478	.939
May 28, 1928	--------	29.79	85.2	82.4	1.54	.762	[4] .378	[4] .443	.853

See footnotes at end of table.

Table 10.—*Influential meteorological factors, and evaporation as observed and as computed from formula 6, at stations of different altitudes*—Continued

Date	Precipitation	Mean barometer [1] reading	Mean temperature: Air	Mean temperature: Water	Mean ground wind velocity	Mean vapor pressure difference, e_s-e_d	Evaporation: Observed per 24 hours	Evaporation: Computed per 24 hours	Evaporation: Ratio observed to computed
	Inch	*Inches of mercury*	*° F.*	*° F.*	*Miles per hour*	*Inch of mercury*	*Inch*	*Inch*	
LAKE TAHOE, CALIF. (ELEVATION, 6,300 FEET)									
June 9, 1928	---------	23.87	58.0	64.5	0.82	0.413	0.256	0.234	1.094
June 10, 1928	Trace.	23.68	55.4	60.2	2.22	.387	.324	.279	1.160
June 11, 1928	0.156	23.61	40.0	49.9	.78	.161	.067	.089	.753
June 12, 1928	.015	23.74	49.0	52.0	.38	.151	.064	.076	.842
June 13, 1928	---------	23.82	54.8	61.7	.80	.330	.180	.184	.979
June 14, 1928	---------	23.84	56.4	63.9	.65	.354	.201	.192	1.047
June 15, 1928	---------	23.85	56.3	63.9	.85	.405	.235	.229	1.025
June 16, 1928	---------	23.81	57.0	64.2	1.09	.426	.258	.259	.997
June 17, 1928	---------	23.76	57.8	65.1	.86	.401	.229	.231	.992
June 18, 1928	---------	23.70	58.4	65.6	1.33	.456	.284	.274	1.036
June 19, 1928	---------	23.72	56.4	64.2	.68	.442	.235	.238	.988
June 20, 1928	---------	23.71	60.2	65.5	1.55	.427	.277	.266	1.041
June 21, 1928	---------	23.78	56.3	62.7	1.25	.399	.270	.252	1.072
LOGAN, UTAH (ELEVATION, 4,778 FEET)									
June 26, 1928	---------	24.97	72.8	71.8	1.90	0.467	[4] 0.235	[4] 0.259	0.907
June 27, 1928	---------	24.92	72.5	73.4	1.86	.559	.318	.355	.896
June 28, 1928	---------	24.95	69.8	71.2	1.91	.533	.320	.355	.902
June 29, 1928	0.001	24.97	69.9	73.1	1.27	.545	.289	.327	.884
June 30, 1928	---------	25.07	65.1	70.2	1.42	.471	.273	.291	.939
July 1, 1928	.106	25.02	62.7	69.5	1.30	.403	.215	.256	.840
July 2, 1928	---------	25.13	63.0	67.8	1.60	.389	.220	.238	.925
July 3, 1928	---------	25.06	71.7	71.3	2.17	.509	.329	.346	.951
July 4, 1928	---------	25.05	70.3	69.3	2.69	.516	.371	.392	.947
July 5, 1928	---------	25.06	73.4	71.2	2.57	.527	.378	.394	.960
July 6, 1928	.043	25.06	69.3	72.8	1.45	.479	.299	.301	.994
July 7, 1928	.138	25.21	55.4	60.8	1.58	.260	.186	.166	1.120
July 8, 1928	---------	25.28	64.6	68.1	2.22	.422	.261	.282	.927
July 9, 1928	---------	25.16	71.3	70.9	2.47	.499	.334	.352	.949
PIKES PEAK, COLO. (ELEVATION, 14,109 FEET)									
Aug. 12, 1928	---------	18.060	39.7	42.6	4.52	0.119	[4] 0.094	[4] 0.090	1.045
Aug. 13, 1928	---------	18.076	38.8	39.7	2.49	.100	[4] .066	[4] .068	.970
Aug. 14, 1928	---------	18.073	41.6	42.9	3.23	.110	.097	.089	1.089
Aug. 15, 1928	---------	18.084	42.3	43.1	4.06	.101	.098	.091	1.077
Aug. 16, 1928	---------	18.083	42.2	47.5	4.51	.122	.116	.111	1.045
Aug. 17, 1928	0.030	18.091	36.7	42.4	3.26	.070	.079	.058	1.362
Aug. 18, 1928	---------	18.086	35.9	36.3	5.01	.089	.095	.091	1.044
Aug. 19, 1928	---------	18.091	43.6	45.0	4.77	.188	.195	.183	1.066
Aug. 20, 1928	---------	18.061	45.6	45.3	10.24	.189	.283	.288	.983
Aug. 21, 1928	---------	18.083	41.4	42.3	11.03	.123	.197	.196	1.005
Aug. 22, 1928	---------	18.049	41.6	41.9	12.73	.094	.179	.174	1.028
Aug. 23, 1928	Rain.	17.962	36.9	38.7	9.55	.086	.151	.133	1.135

See footnotes at end of table.

TABLE 10.—*Influential meteorological factors, and evaporation as observed and as computed from formula 6, at stations of different altitudes*—Continued

FORT COLLINS, COLO. (ELEVATION, 5,000 FEET)

Date	Precipitation	Mean barometer[1] reading	Mean temperature		Mean ground wind velocity	Mean vapor pressure difference, e_s-e_d	Evaporation		
			Air	Water			Observed per 24 hours	Computed per 24 hours	Ratio observed to computed
	Inch	*Inches of mercury*	° *F.*	° *F.*	*Miles per hour*	*Inch of mercury*	*Inch*	*Inch*	
Sept. 10, 1928	---------	24.961	60.6	64.2	0.80	0.313	0.172	0.165	1.041
Sept. 11, 1928	0.035	24.971	56.5	58.9	1.41	.210	.120	.126	.953
Sept. 12, 1928	---------	24.935	54.8	60.0	1.58	.314	.209	.220	.951
Sept. 13, 1928	---------	24.833	61.0	61.8	2.40	.359	.247	.260	.950
Sept. 14, 1928	---------	25.044	57.7	56.5	3.40	.279	.256	.246	1.040
Sept. 15, 1928	---------	25.108	57.8	63.2	.56	.346	.169	.180	.939
Sept. 16, 1928	---------	25.197	62.8	65.2	1.69	.352	.189	.216	.876
Sept. 17, 1928	---------	25.288	59.6	63.9	.99	.321	.171	.187	.915
Sept. 18, 1928	---------	25.060	62.4	65.6	.54	.299	.151	.150	1.006
Sept. 19, 1928	---------	24.882	65.0	62.0	1.14	.283	.162	.169	.959
Sept. 20, 1928	.029	24.923	61.3	62.2	2.00	.278	.200	.199	1.005
Sept. 21, 1928	---------	25.240	48.5	55.6	.61	.209	.102	.109	.937
Sept. 22, 1928	---------	25.234	52.3	59.1	.70	.296	.157	.161	.975
Sept. 23, 1928	---------	25.198	52.4	59.7	.86	.305	.145	.168	.863
Sept. 24, 1928	---------	25.067	53.4	59.0	.65	.275	.129	.141	.915
Sept. 25, 1928	---------	25.048	50.0	58.1	1.04	.259	.143	.142	1.007
Sept. 26, 1928	---------	24.974	51.2	57.4	.82	.230	.128	.121	1.058
Sept. 27, 1928	---------	25.143	47.7	54.8	.38	.266	.137	.139	.986
Sept. 28, 1928	---------	25.044	52.9	52.8	.84	.178	.090	.102	.882
Sept. 29, 1928	---------	25.121	58.6	57.0	.93	.245	.140	.143	.979
Sept. 30, 1928	---------	25.040	58.1	61.0	.56	.312	.155	.163	.952
Oct. 1, 1928	---------	24.934	61.3	60.4	1.43	.298	.169	.176	.961
Oct. 2, 1928	---------	24.966	51.0	57.8	.64	.288	.143	.156	.917
Oct. 3, 1928	---------	24.727	54.8	58.0	.58	.292	.155	.154	1.006
Oct. 4, 1928	0.012	24.676	58.2	57.8	1.44	.271	.175	.165	1.061
Oct. 5, 1928	---------	25.001	51.2	54.5	1.11	.262	.171	.162	1.055
Oct. 6, 1928	---------	25.150	51.4	56.2	.35	.279	.122	.137	.891
Oct. 7, 1928	---------	25.146	51.4	54.0	.61	.217	.127	.116	1.094
Oct. 8, 1928	---------	25.034	59.8	57.2	.61	.276	.140	.140	1.000
Oct. 9, 1928	---------	25.114	54.8	57.9	.40	.282	.134	.142	.944
Oct. 10, 1928	---------	24.868	60.7	60.0	.55	.307	.144	.157	.917
Oct. 11, 1928	---------	24.701	52.1	56.3	1.24	.247	.147	.143	1.028
Oct. 18, 1928[5]	---------	25.046	43.8	48.8	1.07	.133	.065	.074	.878
Oct. 19, 1928	---------	25.150	43.0	48.7	.76	.128	.066	.070	.943
Oct. 20, 1928	---------	25.033	46.2	50.2	.56	.153	.079	.080	.988

[1] Barometer readings reduced to 32° F.
[2] Computed from altitude.
[3] 18-hour period.
[4] 21-hour period.
[5] Observations discontinued from Oct. 12 to Oct. 17 on account of stormy weather.

The effect of altitude on evaporation is shown by the differences between the observed and computed evaporation in Table 10 and also by ratios. Since the rate of evaporation at the different altitudes is a variable, the actual differences are not comparable one station with another. For that reason the ratios were determined. In view of the fact that only a short series of observations could be taken at each station, and since errors are inherent in all evaporation observations, the mean ratio of the observed to the computed evaporation probably does not show the true influence of altitude. However, by computing the probable error for the series it is possible to state the limits within which the error probably lies.

A study of Table 10 shows that there are considerable variations in the ratios of observed to computed evaporation at each station, and that the greatest variations occur during periods of rainful. A summary of the mean results (Table 12) shows that evaporation increased with the altitude.

The mean ratios, plotted as dots, are shown graphically in Figure 7 in which the barometric readings are the ordinates and the mean ratios are the abscissas. The small arrows are the probable errors of the points. The plotted points show also that the ratio increases as the altitude increases, but it is evident that the ratio for Logan, Utah, is too small. This fact was noted while taking the observations, but a careful scrutiny of the procedure there failed to disclose the cause. However, it was recalled later that a different brand of asphaltic paint was used in coating the interior of the tank at Logan

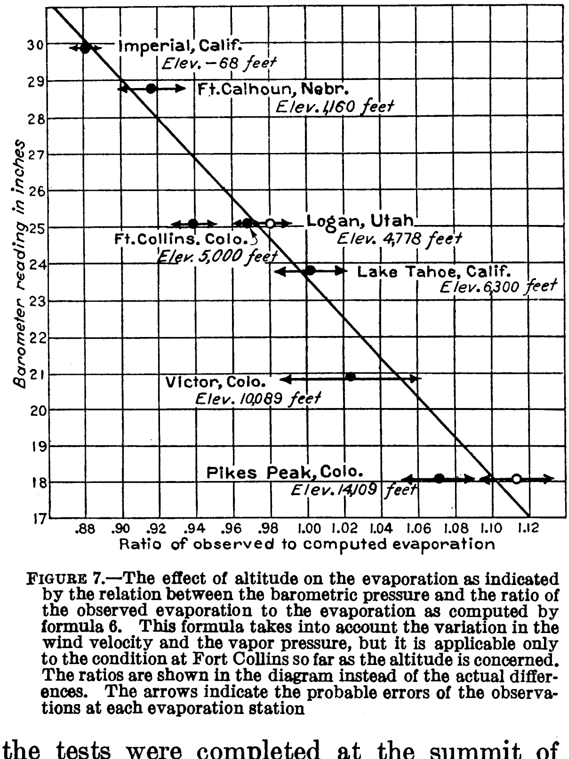


FIGURE 7.—The effect of altitude on the evaporation as indicated by the relation between the barometric pressure and the ratio of the observed evaporation to the evaporation as computed by formula 6. This formula takes into account the variation in the wind velocity and the vapor pressure, but it is applicable only to the condition at Fort Collins so far as the altitude is concerned. The ratios are shown in the diagram instead of the actual differences. The arrows indicate the probable errors of the observations at each evaporation station

and after the tests were completed at the summit of Pikes Peak where the same brand of paint was used, the apparatus was set up at Fort Collins to determine how much of the error was due to the use of this paint.

After coating the interior of the tank with the paint in question, the apparatus was installed in the usual manner at the laboratory at Fort Collins, and a series of observations was made covering a period of 11 days. The results are given in Table 11. According to the theory involved in determining the effect of altitude by the method used, the ratio of the observed to the computed evaporation at Fort Collins should be 1.000. Table 11 shows that the mean ratio for the period was 0.927 ± 0.0076, indicating that the use of this particular paint tended to reduce evaporation.

TABLE 11.—*Influential meteorological factors and evaporation as observed and as computed from formula 6, at Fort Collins, Colo., (elevation 5,000 feet), in tests to determine the influence on evaporation of special paint used in coating tank for tests at Logan, Utah, and Pikes Peak, Colo.*

Date	Precipitation	Mean barometer reading [1]	Mean temperature: Air	Mean temperature: Water	Mean ground-wind velocity	Mean vapor pressure difference $e_s - e_d$	Evaporation: Observed per 24 hours	Evaporation: Computed per 24 hours	Evaporation: Ratio observed to computed
	Inch	*Inches of mercury*	*°F.*	*°F.*	*Miles per hour*	*Inch of mercury*	*Inch*	*Inch*	
Aug. 29, 1928	--------	25.108	67.0	68.5	1.07	0.360	0.185	0.201	0.920
Aug. 30, 1928	--------	25.152	63.4	68.4	.68	.389	.207	.212	.977
Aug. 31, 1928	--------	25.132	62.8	64.7	.77	.306	.153	.164	.933
Sept. 1, 1928	--------	25.213	61.7	65.0	.79	.297	.149	.165	.903
Sept. 2, 1928	0.002	25.227	59.4	61.6	.91	.264	.126	.149	.846
Sept. 3, 1928	--------	25.160	61.3	63.1	.65	.289	.143	.156	.917
Sept. 4, 1928	.031	25.070	59.1	62.6	.85	.283	.148	.159	.931
Sept. 5, 1928	--------	25.138	65.5	66.9	.72	.380	.186	.206	.904
Sept. 6, 1928	--------	25.139	61.9	67.3	.55	.366	.178	.192	.927
Sept. 7, 1928	--------	25.066	66.5	67.4	.50	.330	.163	.166	.982
Sept. 8, 1928	--------	25.018	68.7	67.1	.79	.377	.201	.211	.953
Mean	--------	25.129	--------	--------	--------	--------	--------	--------	[2] .927

[1] Barometer readings reduced to 32° F. [2] Probable error ±0.0076.

Another series of observations covering a period of 35 days was then made at Fort Collins using the original brand of paint. The results are shown in Table 10. The mean ratio of the observed to the computed evaporation for this series was 0.968 ± 0.0067. The difference, 0.968 − 0.927 = 0.041, represents the change due to the different brand of asphaltic paint. Whether this difference is significant can be determined as follows (*16, pp. 26–43; 24: 18*):

$$\text{Probable error of the difference} = \sqrt{0.0076^2 + 0.0067^2} = \pm 0.0101.$$

$$\frac{\text{Difference}}{\text{Probable error of difference}} = \frac{0.041}{0.0101} = 4.06$$

that is, the difference is 4.06 times the probable error of the difference. The odds that this difference is significant are 162 to 1 (*16*), and consequently the mean ratios for Logan and Pikes Peak have been increased by 0.041 to correct the error caused by using the different brand of asphaltic paint. The corrected points, plotted as circles on Figure 7, fall quite close to a mean line drawn through all the points. The point for Victor, Colo., is farthest from the line, but it will be noted that the probable error for this point is the greatest of any of the series, and therefore a greater variation is to be expected.

DERIVATION OF FORMULA

The equation of the mean line derived by the method of least squares, is

$$R = (1.439 - 0.0186\ B), \qquad (8)$$

in which R and B are as given on page 2. This is the equation of the line shown in Figure 7. It passes through all the points within the limits of their probable errors. Since the results of any other series of an equal number of observations at the same location are as likely as not to fall anywhere within the limits of the probable error, the plotted points fall closer to the line than could reasonably be expected from the theory of errors. For Fort Collins, the line shows a ratio of 0.974, but as previously explained tests of formula 6 under a wide range of conditions and on both sunken and floating tanks (Table 16) show that at Fort Collins the ratio should be 1.000. To satisfy this requirement it was necessary to increase the constant in equation 8 by the difference between 1.000 and 0.974 or 0.026. The resulting equation is

$$R=(1.465-0.0186\ B). \qquad (9)$$

This obviously changes the ratio for all the other points by a similar amount but does not change appreciably their relation to the evaporation at Fort Collins. If it were possible to carry on the observations at each point for several years, the points would presumably fall on the new line. The mean ratios computed by formula 9 are given in Table 12, the stations being arranged in the order of increasing altitude. A comparison of the computed ratios with the observed ratios as corrected shows that the maximum deviation is 5.4 per cent. That is, the maximum deviation of the mean computed evaporation from the mean observed evaporation as corrected, for the wide range of altitudes and meteorological conditions encountered in the observations, was 5.4 per cent.

TABLE 12.—*Summary of the results of observations on the influence of altitude on evaporation, and comparison of corrected ratio of evaporation as observed to that computed by formula 6, with ratio computed by formula 9*

Station	Days of record	Mean barometer reading	Altitude above sea level	Ratio, observed to computed evaporation	Corrected ratio, observed to computed evaporation	Ratio computed by formula 9	Deviation from corrected ratio
	Number	*Inches of mercury*	*Feet*				*Per cent*
Imperial, Calif.	14	29.86	−68	0.881±0.0090	0.881±0.0090	0.910	3.3
Fort Calhoun, Nebr.	9	28.77	1,160	.917± .0185	.917± .0185	.930	1.4
Logan, Utah	14	25.06	4,778	.939± .0117	.980± .0117	.999	1.9
Fort Collins, Colo.	35	25.024	5,000	.968± .0067	.968± .0067	1.000	3.3
Lake Tahoe, Calif.	13	23.76	6,300	1.002± .0197	1.002± .0197	1.023	2.1
Victor, Colo.	8	[1] 20.8	10,089	1.023± .0385	1.023± .0385	1.078	5.4
Pikes Peak, Colo.	12	18.067	14,109	1.071± .0199	1.112± .0199	1.129	1.5

[1] Computed from known altitude at Victor, Colo., and barometer reading at Fort Collins, Colo.

Adding the correction factor for altitude $R=1.465-0.0186\ B$, to evaporation formula 6, gives the following general evaporation formula for any altitude from 68 feet below sea level to 14,109 feet above sea level,

$$E=(1.465-0.0186\ B)\ (0.44+0.118W)\ (e_s-e_d). \qquad (10)$$

To simplify the use of the formula, Table 13, giving values of the altitude factor $(1.465-0.0186\ B)$, has been prepared for each 1,000 feet in elevation from 0 to 15,000.

INFLUENCE OF SIZE AND SHAPE OF TANK ON EVAPORATION AT FORT COLLINS, COLO.

The observations under both controlled and exposed conditions from which general evaporation formula 10 was derived, were all made on tanks 3 feet square. It was thought desirable to make observations on tanks of different shapes and sizes to determine the influence of these factors on the evaporation and also to see how closely the results computed from the evaporation formula agreed with the observed evaporation from the different tanks.

EQUIPMENT

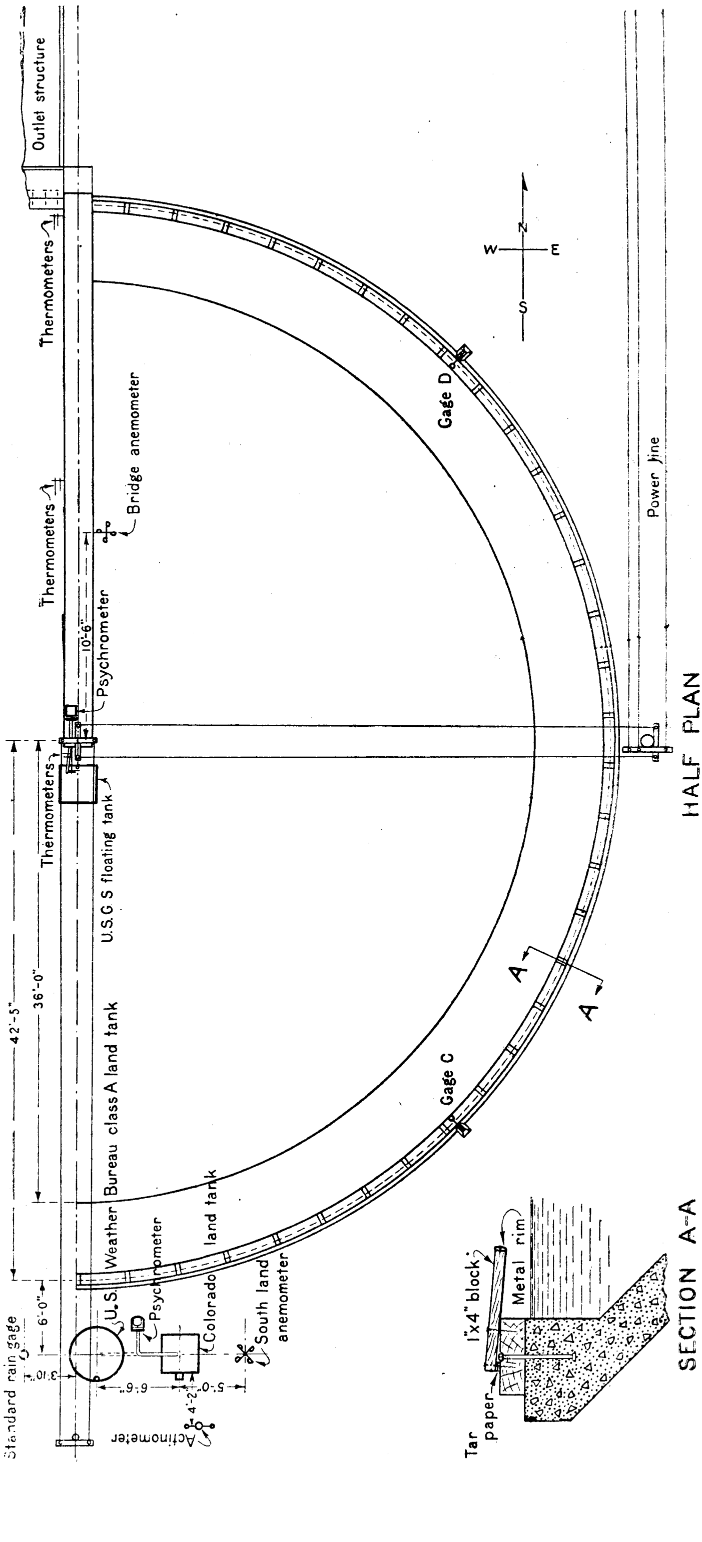
Observations were made on three different standard evaporation tanks and on an artificial reservoir 85 feet in diameter. The standard tanks consisted of a United States Geological Survey floating pan, a Colorado sunken pan, and a United States Weather Bureau class A land pan. It was originally planned to construct a metal-lined tank 100 feet in diameter for the large evaporation pan, but this did not prove feasible so the storage reservoir at the hydraulic laboratory was lined for this purpose.

TABLE 13.—*Values of the factor (1.465–0.0186B) for altitudes of from 0 to 15,000 feet above sea level*

Altitude feet	Barometer reading [1]	Altitude factor	Altitude feet	Barometer reading [1]	Altitude factor
	Inches of mercury			*Inches of mercury*	
0	29.90	0.91	8,000	22.28	1.05
1,000	28.82	.93	9,000	21.47	1.07
2,000	27.78	.95	10,000	20.70	1.08
3,000	26.78	.97	11,000	19.95	1.09
4,000	25.81	.98	12,000	19.23	1.11
5,000	24.88	1.00	13,000	18.53	1.12
6,000	23.98	1.02	14,000	17.86	1.13
7,000	23.11	1.04	15,000	17.22	1.14

[1] Mean barometer reading at 32° F. from Smithsonian Meteorological Tables (*32*).

The United States Geological Survey standard floating pan is a galvanized-iron tank 3 feet square and 1½ feet deep. It was set near the center of the large reservoir with its top edge about 3 inches above the water surface, as shown in Plate 7, A, and Figure 8. The maximum distance from the top edge of the tank to the water surface was 3½ inches, and the minimum 2½ inches. According to the standard plan of the Geological Survey the tank is floated within a raft, but since the depth of water in the large reservoir had a maximum variation of only 1 inch, it was thought that better results could be obtained by supporting the tank in a fixed position because of the difficulty in obtaining accurate gage readings in a floating tank. During the first season the tank was in use, some difficulty was experienced on account of water splashing into the tank from the reservoir during heavy winds. This condition was corrected by building a metal barrier 10 inches high and 5 feet long on each side of the tank. The top of the barrier was at the elevation of the water surface of the reservoir. The barrier is shown in Figure 8 and is visible beneath the water surface in Plate 7, A.


Outlet structure
Thermometers
Thermometers
Bridge anemometer
10'-6"
Psychrometer
Thermometers
U.S.G.S floating tank
42'-5"
36'-0"
U.S. Weather Bureau class A land tank
Psychrometer
Colorado land tank
South land anemometer
Standard rain gage
6'-0"
3'-10"
6'-6"
4'-2"
5'-0"
Actinometer
Gage D
Gage C
Power line
N
S
E
W
A
A
HALF PLAN
1"x4" block
Metal rim
Tar paper
SECTION A-A

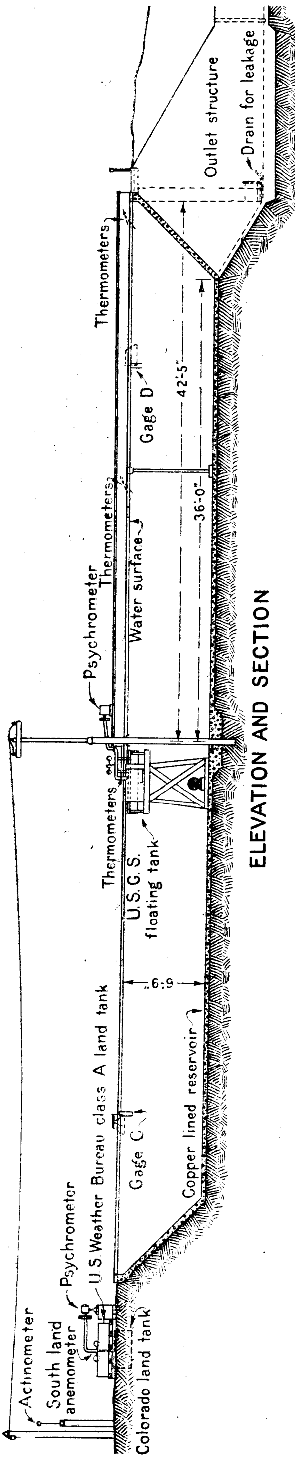


FIGURE 8.—Arrangement of the equipment for conducting experiments on the evaporation from the 85-foot circular reservoir and the various standard tanks, Fort Collins, Colo.

The Colorado pan is a galvanized-iron tank 3 feet square and 18 inches deep, sunk in the ground with its top edge 1¾ inches above the ground surface, as shown in Plate 7, B. The standard depth of the Colorado tank is 3 feet, but experiments have shown that the depth of the tank has very little effect upon the evaporation (*30, p. 218–226, Pl. 37, B*). The allowance for variation in the water surface was 1 inch, and the maximum distance of the surface below the top edge of the tank was 2 inches. The tank was set about 5 feet south of the large reservoir and 3 feet east of the Weather Bureau tank. (Pl. 7, B, and Fig. 8.)

The United States Weather Bureau class A land pan is a circular galvanized-iron tank 4 feet in diameter and 10 inches deep, supported on a grillage of timbers so as to allow a free circulation of air all around it. The top edge of the tank was 14 inches above the ground, and 2 inches above the water surface at the maximum and 1 inch at the minimum condition. This tank was set 4 feet from the south edge of the large reservoir. (Fig. 8.)

As stated, the storage reservoir at the hydraulic laboratory was used for the large tank. This is a circular concrete-lined reservoir 85 feet in diameter and 6 feet 9 inches deep, with 1 to 1 side slopes. The top of the reservoir is about 4 inches above the general ground level. The maximum distance of the water surface below the top edge of the tank was 4 inches and the minimum 3 inches. A portion of the reservoir with its surrounding fence is shown in Plate 8, A, and its location with respect to the small tanks is shown in Figure 8.

To eliminate probability of leakage, the reservoir was lined with 14-ounce soft copper sheets with double-soldered flat-lock joints. Radial expansion joints were provided along the quarter lines. Before laying the copper lining the floor and lower portion of the sides of the reservoir were given a heavy coating of hot gas tar and then covered with building paper (pl. 8, B) so as to prevent the copper lining from sticking to the tar. The purpose of the tar coating was to provide a cushion for the copper lining and a means of detecting leakage from the reservoir. Detection of leakage was then possible because the floor of the reservoir was built with a slope toward the outlet structure which was located on the north side of the reservoir below the general level of the floor. A three-fourth inch pipe through the wall at the lowest point of the outlet structure furnished a means of escape of any water that leaked through the copper lining and worked its way along the floor between the lining and the tar-covered concrete to the outlet structure. This device functioned satisfactorily for testing the reservoir when first filled and later made it possible to detect a small leak caused by the cracking of one of the soldered joints.

During the first season, considerable water splashed out of the reservoir in severe windstorms. To prevent this a rim of galvanized iron, as shown in Plate 7, B, was nailed to the coping of the reservoir. This rim consisted of strips of galvanized iron about 10 inches wide and 4 feet long, with a ¾-inch flange, made by bending over the edges of the strips, along each side. To increase the stiffness of the edge extending over the water, this flange was made of two thicknesses of metal. The rim projected about 6 inches over the water surface and was secured by blocks nailed to the reservoir coping. The back flange was designed to intercept any water that splashed up on the sheet. The water caught in this manner drained back into the reservoir through a series of holes punched along the inner edge of the sheet. To keep the water from being driven between the sheets and the top of the reservoir coping, strips of roofing paper painted with asphalt were placed under the back edges of the sheets. These strips also gave the sheets the slope necessary to drain back into the reservoir the water splashing on them. This rim proved very effective and reduced the loss from splashing to a negligible quantity.

AUXILIARY EQUIPMENT

Thermometers were placed in all the tanks for taking the temperature of the water surface and of the air 1 inch above. Each of the standard tanks was equipped with one set of thermometers, but owing to its large size three sets were used in the reservoir—one at the center, one near the circumference, and one half way between the other two. The thermometers were graduated in degrees or half degrees, with a range from $-30°$ to $+120°$ F. These and the psychrometer thermometers were compared with a special thermometer calibrated by the United States Bureau of Standards and were found to be accurate within the limit of error of the method of calibration. Metal shields painted white were used to protect the thermometers from the direct rays of the sun. Additional protection to prevent possible breakage by hail was provided by placing over each set of thermometers a one-fourth inch mesh wire-cloth screen.

Modified Assmann type psychrometers were used in determining the vapor pressure of the air. Two psychrometers were used each of which, by suitably jointed pipes, was made to serve two tanks. The one used at the Colorado pan and the Weather Bureau pan, with its tube adjustable to either pan, is shown in Plate 7, B. In each case the psychrometers drew the air from a point near the center of the tank and from a level 1 to 2 inches above the water surface, depending on whether the water surface was near the upper or the lower limit of its range in the tank. During the warm part of the first season, 20-inch thermometers with a range of from $+20°$ to $+120°$ F., by tenths of a degree, were used in the psychrometers,

A, United States Geological Survey floating tank and 85-foot circular reservoir (wave barrier is visible beneath the water surface at the center of the reservoir); B, Colorado sunken tank and United States Weather Bureau class A land pan, with auxiliary equipment. Metal rim around reservoir for reducing loss due to splashing is shown

A, General arrangement of equipment for conducting experiments on the evaporation from the 85-foot circular reservoir and the various standard tanks; B, placing copper on floor of 85-foot reservoir (tar coating partially covered with building paper is visible in uncompleted portion); C, micrometer hook gauge supported by cantilever arm attached to concrete block. Stilling well is also shown but later when the temperature dropped below freezing these thermometers were replaced by sling-psychrometer thermometers with a range from $-30°$ to $+120°$ by degrees, and these were used thereafter. The psychrometers of the Assmann type had previously been tested and found satisfactory. (Table 1.)

Robinson 4-cup anemometers of the United States Weather Bureau type were used to determine the wind velocities. One was placed 7 feet west of the west edge of the reservoir, one on the south side of the reservoir 3½ feet east of the Colorado tank, and one on the reservoir bridge 10½ feet from the center of the reservoir. The bridge anemometer is shown in Figure 8 and Plate 7, A. The south and west anemometers were approximately 16 and 19 inches, respectively, above the ground, and the bridge anemometer was 30 inches above the water surface.

The evaporation losses were measured with micrometer hook gages, reading to thousandths of an inch and having a 1-inch range. (Fig. 5.) One gage was rigidly attached to each of the small tanks by means of a metal standard bolted to the side of the tank, and four gages mounted on concrete blocks cast in place with their bases 1 foot beneath the surface of the ground (pl. 8, C) were placed at the quarter points on the circumference of the reservoir. A special hook gage of the Hoff type (*31*) was attached to the column at the center of the reservoir. This gage had an especially wide range and was installed for use when, during heavy rainstorms, the water levels rose above the scale limits of the micrometer hook gages. The necessity for the use of the Hoff gage was eliminated during the last season by providing a 1-inch extension for the micrometer hook gages. This extension consisted of an auxiliary point 1 inch long which could be dropped over the micrometer hook gage points. It was held vertical by a weight in the form of a pendulum attached to the lower part of the extension.

Each gage was equipped with a stilling well having one small inlet for the water. To eliminate the effect of water piling up on one side of the tank when the wind was blowing, the center surface levels in the Weather Bureau land pan and the Geological Survey floating pan were transferred to the stilling well through a tube leading from the center of the tank to the well. The hook gages and stilling wells gave very satisfactory results, and the readings on the four hook gages around the reservoir during periods when there was no wind showed that a high degree of accuracy was possible with this equipment.

Precipitation was measured in a standard rain gage of the Weather Bureau type. The top of the gage was 36 inches above the ground. The location of the gage is shown in Figure 8, and the gage itself is shown behind the Weather Bureau tank in Plate 7, B.

The atmosphere pressure was taken with a mercurial barometer in the office of the hydraulic laboratory, about 60 feet north of the reservoir and 6 feet below the level of the water surface in the reservoir; however, the variations in pressure were not sufficient to cause a noticeable effect on the evaporation. In all computations the normal barometer reading at Fort Collins 24.990 inches of mercury at 32° F. was used.

Actinometer readings were taken for the purpose of determining the solar radiation, but no use was made of the observations in analyzing the evaporation data. The location of the actinometer is shown in Figure 8.

LOCATION OF EQUIPMENT

The use of the storage reservoir of the hydraulic laboratory as the large evaporation tank made it necessary to locate the other evaporation tanks at this point so that they would operate under similar conditions. This location has some desirable features—such as accessibility to water and power—but on the other hand, wind movement is obstructed to some extent by the surrounding trees and near-by buildings. (Pl. 9, A.) This difficulty was overcome in some measure by using several anemometers, placed at different points, for determining the mean wind volocity. The reservoir is on the top of a hill, and the ground slopes away sharply to the west and north but is comparatively level toward the east and south. Since the level land to the east was occupied by a 1-story building, the land tanks were installed in the level area to the south of the reservoir.

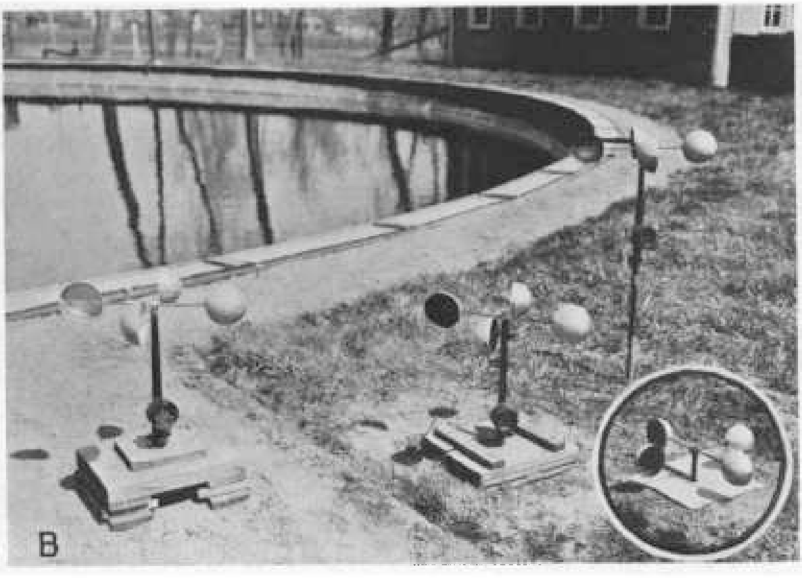
METHOD OF TAKING OBSERVATIONS

The observations were taken at approximately 6-hour intervals—at 6 a. m., 12 noon, 6 p. m., and 12 midnight during the first two seasons; and at 7 a. m., 1 p. m., and 7 p. m., during the last season except for the first two weeks in April, when the observations were taken only at 7 a. m. and 7 p. m. The observations consisted of air, water, and the wet and dry-bulb temperatures; micrometer hook-gage readings for each of the standard tanks and the reservoir; anemometer readings; time of the observations; and precipitation and barometer readings. The readings were always taken in the same order so there was little chance of omitting any of them.

All temperature readings were taken to the nearest tenth of a degree by direct readings on thermometers graduated in tenths, and by estimation on thermometers graduated in degrees or half degrees. The micrometer hook-gage readings were made to thousandths of an inch.

The total wind movement was read direct in miles and tenths on the dials of the anemometers. The velocity indicated by each anemometer was reduced to the ground-wind velocity by the use of an anemometer-comparison diagram which showed for each anemometer the ground wind corresponding to the indicated wind. This relation was determined at the end of each season by making observations on the anemometers when at the elevations normally occupied (pl. 9, B), simultaneously with readings of one anemometer placed in a pit with the cups at approximately the ground surface, as shown in Plate 9, B (inset). The relation between the anemometers changed somewhat from year to year, so a new diagram was prepared for each season. Figure 9 shows the comparison diagram for 1928.

Slight precipitation was measured in cubic centimeters and then reduced to inches; heavy precipitation was measured directly in inches in a graduate made especially for the type of rain gage employed. Measurement of precipitation in the rain gage did not prove entirely satisfactory, particularly when it occurred as snow, because for some reason more water accumulated in the tanks than fell in the rain gage, area for area, as was shown by the gain in water level in the tanks during the period of precipitation. It was thought that the rain gage might be in error, but testing failed to disclose any inaccuracies. In correcting evaporation for precipitation, factors were applied to take care of the 10-inch rim around the top of the



A, Environs of 85-foot circular reservoir; B, anemometers arranged for comparison; elevations the same as during evaporation observations. Inset shows elevation of anemometer registering ground wind reservoir and of the 2-inch angle iron around the top of the Colorado tank.

Barometer readings were made to the nearest hundredth of an inch, except for short periods when a special barometer reading to 2 one-thousandths of an inch was used.

The tanks were refilled whenever the water level neared the lower limit of the scale of the micrometer gage. Since the range of the scale was only 1 inch, it was necessary to refill the tanks twice a week during certain periods of the year. The time record was corrected for the time required to do this. All the tanks were thoroughly cleaned at the beginning of each season and at least once during the season. The small tanks were refilled each time with fresh water from the city water supply; but the same water was used in the large reservoir for three seasons, only the water lost during the cleaning being replaced by fresh water.

An analysis of the reservoir water made in July of the third season showed that the total solids amounted to only 45 parts per million. Analyses made at the same time of the waters in the Weather Bureau and Colorado tanks showed solids amounting, respectively, to 158and 228 parts per million. The sample from the Geological Survey floating tank was not analyzed at the time. As heretofore explained, it was learned that after several months the water dissolved the glass of the containers and rendered analyses of no significance.

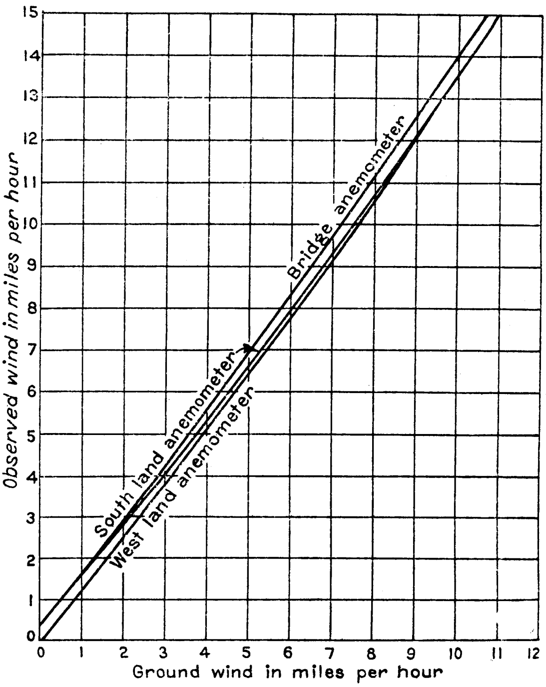


FIGURE 9.—Anemometer comparison diagram for 1928, showing the relation between the observed wind velocity and the ground-wind velocity

No grass was permitted to grow near the small tanks, and that around the large reservoir was mowed frequently so that it should not interfere with the movement of the wind.

The tanks were inspected for leaks at the beginning of each season, and each time the reservoir was cleaned all joints in the lining were carefully inspected. On several occasions the drain under the copper lining dripped water. It was thought that the lining was leaking, but inspection failed to disclose any holes except at the end of the first season, when one of the seams opened on account of the contraction of the lining. The appearance of water in the drain was never satisfactorily explained but might have been caused by the condensation of moisture on the back of the lining since the drain usually started to drip after stormy weather. The quantity thus lost was found to be small as compared with the evaporation.

RESULTS OF OBSERVATIONS

The evaporation observations on the standard tanks and the large circular reservoir conducted during 1926 were started on September 19 and continued until December 6, but the record after November 30 was discarded because the ice in the stilling wells rendered it unreliable. The 1927 and 1928 observations were started in the first week in April and were continued until the last of November. During the three years 1,940 observations were made.

The observations were taken at regular intervals, as previously mentioned, but to simplify the computations and to eliminate so far as possible the effects of changes in temperature, the weighted daily mean values of all data were used in compiling the records. In 1926 and 1927 the 24-hour period chosen was from midnight until midnight, because the temperature at that hour did not vary much from day to day, and there was usually no wind-factors which rendered possible the accurate reading of the micrometer hook gages. After the weather turned cold in the fall and the water began to freeze at night, it was necessary to change to the period from 6 p. m. to 6 p. m. because there was the least likelihood of ice forming in the stilling wells at that time. No midnight observations were taken during 1928, and the 24-hour periods extended from 7 p. m. to 7 p. m.

The mean daily results of the observations taken in 1926, 1927, and 1928 in each of the tanks and in the large reservoir are given in Table 14. In addition, the table gives the record of precipitation as well as the mean daily air temperatures, vapor pressures of the air, and tower wind velocities as taken from the Colorado Agricultural Experiment Station weather records. The air and water temperatures and the differences in vapor pressure are the weighted mean values for the 24-hour periods. In computing these values the ratio of the time interval to which the observations applied, to a 24-hour period, was used as the basis for assigning the weights.

As already explained (p. 47), the mean ground-wind velocities as applied to the circular reservoir, the Geological Survey floating tank, and the Colorado tank, were determined from readings of the three anemometers located at different points and at different elevations. The values given in Table 14 are the means of the ground-wind velocities. For the Weather Bureau tank the wind velocities were taken directly from the readings of the south land anemometer which was near the tank (fig. 8), its cups being at about the same elevation as the top of the tank. The wind velocities were not weighted because the true mean was obtained by taking the difference between the readings at the beginning and at the end of each 24-hour period.

TABLE 14.—*Evaporation from a circular reservoir and from standard tanks at Fort Collins, Colo. (elevation 5,000 feet, barometric pressure 24.990 inches), as observed and as computed from formula 10, and pertinent meteorological data*

Date	Reservoir						Geological Survey floating tank						Colorado type land tank, class A						Weather Bureau land tank, class A						Other meteorological data			
	Meteorological data (mean values for 24 hours)				Evaporation in 24 hours		Meteorological data (mean values for 24 hours)				Evaporation in 24 hours		Meteorological data (mean values for 24 hours)				Evaporation in 24 hours		Meteorological data (mean values for 24 hours)				Evaporation in 24 hours					
	Temperature		Difference in vapor pressure, e_s-e_d	Velocity of wind at ground			Temperature		Difference in vapor pressure, e_s-e_d	Velocity of wind at ground			Temperature		Difference in vapor pressure, e_s-e_d	Velocity of wind at ground			Temperature		Difference in vapor pressure, e_s-e_d	Velocity of wind at ground [1]						
	Air	Water			Observed	Computed	Air	Water			Observed	Computed	Air	Water			Observed	Computed	Air	Water			Observed	Computed	Daily mean air temperature [2]	Daily mean air vapor pressure [2]	Daily mean wind tower velocity [2]	Precipitation
1926	°F.	°F.	Inch of mercury	Miles per hour	Inch	Inch	°F.	°F.	Inch of mercury	Miles per hour	Inch	Inch	°F.	°F.	Inch of mercury	Miles per hour	Inch	Inch	°F.	°F.	Inch of mercury	Miles per hour	Inch	Inch	°F.	Inch of mercury	Miles per hour	Inch
Sept. 20	[3]64.3	65.7	0.226	1.06	0.103	0.128	[3]64.6	65.7	0.245	1.06	0.149	0.139	[3]63.1	63.8	0.236	1.06	0.144	0.134	[3]63.3	63.8	0.247	1.86	0.152	0.163	62.9	0.247	8.00	-----
21	68.4	65.3	.339	2.47	.218	.248	69.3	65.7	.363	2.47	.265	.266	69.5	64.4	.338	2.47	.290	.248	69.3	64.6	.359	3.60	.339	.311	69.4	.216	6.50	0.074
22	61.4	66.9	.257	.55	.088	.130	62.7	67.4	.283	.55	.120	.143	61.7	66.2	.285	.55	.129	.144	62.1	65.8	.294	.93	.135	.162	63.4	.358	3.08	-----
23	56.0	65.6	.355	1.20	.188	.208	55.4	66.9	.397	1.20	.237	.231	56.1	63.4	.380	1.20	.234	.221	55.8	58.9	.298	1.83	.214	.196	57.3	.212	5.92	-----
24	39.5	62.4	.383	.80	.202	.205	39.1	62.9	.415	.80	.215	.222	36.6	53.2	.281	.80	.155	.150	35.2	43.8	.170	1.38	.096	.103	36.2	.114	3.50	-----
25	41.4	59.7	.354	.82	.160	.190	43.3	58.8	.354	.82	.193	.190	39.2	49.6	.229	.82	.128	.123	37.9	41.0	.144	1.31	.097	.086	36.8	.114	4.25	-----
26	41.4	57.3	.316	.49	.134	.157	41.3	55.4	.296	.49	.145	.147	39.2	44.8	.186	.49	.088	.093	38.6	41.4	.137	.88	.054	.075	35.4	.115	2.33	-----
27	49.7	57.9	.266	.72	.102	.140	50.8	57.6	.282	.72	.131	.148	50.0	52.7	.246	.72	.123	.129	39.3	49.4	.219	1.08	.122	.125	48.1	.158	4.17	-----
28	54.2	59.2	.300	.68	.108	.156	55.2	58.3	.308	.68	.149	.160	53.8	55.2	.299	.68	.152	.156	54.4	53.9	.280	1.08	.153	.159	52.8	.150	4.12	-----
29	55.7	59.8	.273	.68	.099	.142	56.6	59.4	.288	.68	.153	.150	56.7	57.5	.309	.68	.155	.161	57.2	57.4	.308	1.05	.177	.174	56.6	.196	4.87	-----
30	55.0	57.8	.227	4.53	[4].304	.221	55.3	57.0	.249	4.53	.251	.243	54.4	54.4	.254	4.53	.267	.248	54.2	53.8	.252	5.84	.334	.284	56.2	.206	14.41	-----
Oct. 1	52.0	58.0	.276	.67	.094	.143	52.8	56.9	.278	.67	.134	.144	52.6	54.1	.274	.67	.122	.142	51.4	51.9	.262	1.31	.129	.156	52.3	.166	3.75	-----
2	54.2	57.7	.227	1.72	.104	.146	54.5	56.8	.219	1.72	.144	.141	55.4	55.7	.217	1.72	.143	.140	54.7	54.6	.210	2.70	.162	.159	53.0	.201	5.88	-----
3	52.0	56.4	.177	2.36	[4].101	.126	52.3	55.6	.167	2.36	.110	.120	51.4	53.6	.162	2.36	.095	.116	51.2	51.8	.138	3.71	.121	.121	54.8	.252	8.46	.084
4	47.0	55.0	.209	3.06	[4].154	.168	47.3	53.5	.195	3.06	.162	.156	45.6	50.1	.164	3.06	.134	.132	45.3	47.4	.137	4.64	.137	.136	49.4	.197	8.33	.001
5	47.6	54.8	.220	1.10	.096	.126	47.7	53.8	.218	1.10	.137	.124	47.0	51.1	.205	1.10	.129	.117	46.6	48.8	.186	1.70	.121	.119	47.3	.170	5.21	-----
6	51.5	56.4	.238	.75	.081	.126	51.8	55.9	.237	.75	.126	.125	51.6	54.3	.252	.75	.129	.133	52.2	53.8	.264	1.27	.137	.156	53.0	.174	3.83	-----
7	53.4	56.9	.262	1.10	.108	.150	54.4	56.7	.265	1.10	.147	.151	54.4	55.4	.286	1.10	.164	.163	55.2	55.5	.296	1.64	.185	.188	55.7	.180	5.75	-----
8	56.6	56.8	.248	2.53	.117	.183	56.8	56.3	.249	2.53	.189	.184	57.9	55.2	.263	2.53	.184	.194	57.3	55.3	.273	3.58	.211	.236	58.2	.198	8.25	.008
9	52.6	57.1	.200	1.08	.089	.113	52.8	56.6	.204	1.08	.117	.116	53.0	55.4	.214	1.08	.132	.121	52.6	55.0	.217	1.61	.153	.135	52.4	.218	4.58	-----
10	59.4	58.9	.254	1.41	.113	.154	60.0	58.1	.251	1.41	.156	.152	59.2	57.7	.291	1.41	.175	.176	59.7	57.6	.306	2.03	.208	.208	59.5	.182	6.04	-----
11	56.8	58.5	.249	1.18	.111	.144	56.8	58.1	.266	1.18	.148	.154	57.9	57.3	.286	1.18	.167	.166	57.5	57.0	.286	1.78	.194	.186	59.1	.188	4.46	-----
12	49.0	57.4	.259	1.00	.103	.145	48.6	56.8	.250	1.00	.135	.140	48.6	53.7	.211	1.00	.137	.118	48.4	54.8	.225	1.63	.140	.142	47.2	.190	4.50	-----
13	51.8	57.5	.249	1.23	.117	.146	52.0	56.8	.252	1.23	.156	.148	51.2	54.5	.258	1.23	.139	.151	52.0	51.7	.229	1.81	.150	.150	53.0	.152	5.42	-----

See footnotes at end of table.

TABLE 14.—*Evaporation from a circular reservoir and from standard tanks at Fort Collins, Colo. (elevation 5,000 feet, barometric pressure 24.990 inches), as observed and as computed from formula 10, and pertinent meteorological data*—Continued

Date	Reservoir						Geological Survey floating tank						Colorado type land tank, class A						Weather Bureau land tank, class A						Other meteorological data			
	Meteorological data (mean values for 24 hours)				Evaporation in 24 hours		Meteorological data (mean values for 24 hours)				Evaporation in 24 hours		Meteorological data (mean values for 24 hours)				Evaporation in 24 hours		Meteorological data (mean values for 24 hours)				Evaporation in 24 hours					
	Temperature		Difference in vapor pressure, e_s-e_d	Velocity of wind at ground			Temperature		Difference in vapor pressure, e_s-e_d	Velocity of wind at ground			Temperature		Difference in vapor pressure, e_s-e_d	Velocity of wind at ground			Temperature		Difference in vapor pressure, e_s-e_d	Velocity of wind at ground [1]						
	Air	Water			Observed	Computed	Air	Water			Observed	Computed	Air	Water			Observed	Computed	Air	Water			Observed	Computed	Daily mean air temperature [2]	Daily mean air vapor pressure [2]	Daily mean wind tower velocity [2]	Precipitation
1926	*°F.*	*°F.*	*Inch of mercury*	*Miles per hour*	*Inch*	*Inch*	*°F.*	*°F.*	*Inch of mercury*	*Miles per hour*	*Inch*	*Inch*	*°F.*	*°F.*	*Inch of mercury*	*Miles per hour*	*Inch*	*Inch*	*°F.*	*°F.*	*Inch of mercury*	*Miles per hour*	*Inch*	*Inch*	*°F.*	*Inch of mercury*	*Miles per hour*	*Inch*
Oct. 14	48.7	57.2	0.276	0.72	.100	.145	49.5	56.6	0.270	0.72	0.137	0.142	46.7	52.9	0.252	0.72	0.130	0.132	47.1	51.1	0.238	1.29	0.141	0.141	50.4	0.152	3.92	----
15	56.1	56.2	.256	1.89	.134	.170	55.0	55.8	.273	1.89	.196	.181	53.7	52.9	.250	1.89	.175	.166	54.2	52.1	.255	2.97	.242	.202	56.9	.132	6.88	----
16	58.6	57.5	.245	1.04	.094	.138	58.9	57.3	.249	1.04	.151	.140	60.2	55.7	.282	1.04	.144	.159	60.5	56.0	.287	1.57	.187	.179	59.0	.141	5.58	----
17	67.6	59.3	.229	1.82	.128	.150	68.1	59.2	.234	1.82	.186	.153	68.1	59.0	.312	1.82	.200	.204	68.9	61.2	.360	2.68	.289	.272	68.4	.173	2.42	----
18	52.0	57.2	.235	1.47	[4] .117	.145	52.1	55.7	.226	1.47	.155	.139	51.5	53.1	.211	1.47	.166	.130	51.9	53.7	.237	2.10	.187	.163	51.9	.190	8.71	----
19	49.6	56.4	.225	2.27	[4] .143	.159	50.6	55.8	.226	2.27	.145	.160	48.3	51.9	.199	2.27	.135	.141	48.5	52.5	.211	3.49	.134	.180	49.6	.190	4.04	----
20	45.2	55.8	.237	.72	.099	.125	45.3	54.9	.227	.72	.134	.119	43.5	51.3	.221	.72	.119	.116	44.2	48.1	.190	1.26	.111	.112	46.2	.150	4.29	----
21	48.9	54.7	.220	.98	.095	.123	49.6	53.8	.214	.98	.125	.119	48.2	49.2	.182	.98	.108	.101	48.6	47.9	.182	1.78	.113	.118	51.6	.155	4.21	----
22	43.1	54.4	.212	.71	.082	.111	43.2	53.7	.208	.71	.106	.109	42.0	48.7	.179	.71	.093	.094	42.3	42.1	.160	1.32	.092	.095	42.3	.160	4.08	----
23	37.3	51.8	.175	1.20	.089	.102	37.3	49.7	.151	1.20	.101	.088	35.1	43.2	.102	1.20	.034	.059	34.4	37.3	.046	1.85	.025	.030	33.2	.166	4.67	0.079
24	47.2	51.4	.188	1.90	.093	.125	47.9	50.6	.172	1.90	.126	.114	46.1	46.2	.142	1.90	.090	.094	46.2	44.1	.121	3.07	.102	.097	47.5	.130	9.33	----
25	57.2	51.2	.179	4.24	.178	.168	54.9	51.1	.174	4.24	.165	.164	56.4	50.5	.196	4.24	.179	.184	57.9	53.9	.252	6.61	.295	.307	59.8	.176	10.62	----
26	48.4	53.3	.198	0.69	[4] .065	.103	48.9	53.0	.197	.69	.096	.103	47.4	51.4	.207	.69	.102	.108	48.4	50.4	.206	1.22	.118	.120	52.1	.173	4.33	----
27	53.5	53.0	.198	2.03	[4] .115	.135	54.2	52.9	.206	2.03	.128	.140	52.9	51.4	.206	2.03	.121	.140	54.0	52.5	.235	2.79	.154	.181	56.2	.188	7.46	----
28	41.4	50.9	.134	1.26	.041	.079	41.8	49.4	.120	1.26	.055	.071	40.6	46.7	.100	1.26	.032	.059	40.5	43.7	.075	1.76	.037	.049	39.6	.206	5.96	.108
[5] 30	32.9	46.6	.140	.35	.072	.067	34.5	46.0	.136	.35	.067	.065	31.4	37.3	.054	.35	.017	.026	31.1	33.5	.032	.68	.013	.017	23.6	.092	2.92	.017
31	37.9	47.7	.132	.39	.070	.064	38.0	48.1	.148	.39	.072	.072	33.5	40.0	.079	0.39	.023	.038	34.2	35.8	.048	.78	.021	.025	33.5	.117	3.62	----
Nov. 1	37.8	45.9	.092	1.45	.050	.056	36.8	45.6	.101	1.45	.055	.062	36.2	40.8	.056	1.45	.024	.034	36.0	37.4	.032	2.34	.008	.023	37.2	.175	4.12	.075
2	35.9	44.4	.103	1.42	[4] .061	.063	36.3	43.4	.098	1.42	.052	.060	33.7	38.3	.061	1.42	.030	.037	34.8	35.5	.040	2.38	.036	.029	36.9	.152	7.50	----
3	36.0	43.6	.098	1.66	.025	.062	35.8	42.8	.091	1.66	.023	.058	34.0	38.2	.057	1.66	−.016	.036	34.1	35.8	.040	2.52	−.013	.029	32.2	.154	3.38	.247
4	31.3	43.4	.126	.55	.045	.064	32.3	41.6	.111	.55	.053	.056	28.3	36.0	.068	.55	.025	.034	30.1	35.4	.069	.98	.022	.038	35.1	.118	3.50	----
5	38.5	44.1	.102	.67	.036	.053	39.8	43.8	.107	.67	.050	.056	36.4	36.3	.032	.67	.026	.017	37.6	38.8	.066	1.23	.031	.039	44.2	.126	4.63	----
6	44.7	43.4	.111	1.41	.047	.067	45.6	43.8	.123	1.41	.076	.075	43.6	41.2	.105	1.41	.054	.064	45.5	42.4	.135	2.23	.085	.095	46.1	.119	13.26	----
7	43.8	42.9	.087	7.11	([4])	----	45.8	42.8	.097	7.11	.103	.124	44.9	41.8	.104	7.11	.127	.133	46.3	43.1	.128	10.70	.172	.218	44.0	.160	22.05	.005
8	37.9	41.3	.113	6.13	[4] .179	.132	38.2	40.7	.104	6.13	.130	.120	36.2	37.0	.084	6.13	.108	.098	37.0	36.1	.084	9.50	.136	.131	36.9	.116	6.25	----
9	0.23	38.9	.104	.40	.033	.051	30.6	35.0	.074	.40	.038	.036	27.3	33.1	.068	.40	.026	.033	38.3	34.5	.083	.94	.037	.046	34.8	.105	3.25	----

10	35.6	40.2	.102	.48	.030	.051	36.4	38.1	.093	.48	.046	.046	34.0	33.5	.062	.48	.031	.031	35.7	36.2	.087	1.00	.043	.049	39.6	.115	3.54	-----
11	43.0	42.0	.070	.17	.015	.032	42.5	42.0	.072	.17	.024	.032	41.8	39.8	.058	.17	.018	.027	42.2	40.8	.071	.51	.033	.036	43.8	.162	3.21	-----
12	46.2	42.1	.098	1.38	.041	.059	46.9	43.2	.111	1.38	.066	.067	44.9	43.4	.124	1.38	.061	.075	47.0	44.7	.149	2.27	.081	.106	48.9	.146	6.58	-----
13	42.6	42.2	.108	2.89	.064	.084	41.2	41.4	.102	2.89	.083	.080	41.2	41.3	.100	2.89	.079	.078	42.6	42.0	.113	4.64	.118	.112	40.4	.138	17.16	-----
14	40.1	40.3	.134	7.49	[4].214	.177	39.6	38.9	.118	7.49	.146	.156	39.4	37.5	.110	7.49	.135	.145	40.2	37.1	.112	12.00	.179	.208	41.4	.109	18.06	-----
15	39.1	38.8	.126	5.07	[4].129	.130	38.9	36.9	.112	5.07	.137	.116	37.4	34.9	.106	5.07	.094	.110	38.2	34.4	.108	7.68	.140	.145	41.4	.126	10.90	-----
19	27.8	32.7	.067	.66	[6].024	.035	29.5	31.6	.059	3.28	[7].063	.049	29.5	31.9	.070	3.56	[8].037	.060	30.5	32.0	.074	3.88	[8].052	.080	[9]32.7	.104	[9]10.82	.002
[10]22	26.6	32.3	.051	.95	.015	.028	26.3	30.3	.038	.95	.023	.021	25.4	[11]30.7	[11].044	.95	.038	.024	25.9	30.7	.044	1.60	.031	.028	[12]32.1	[12].112	[12]5.10	-----
23	47.2	33.6	.030	2.51	.024	.022	45.7	33.7	.036	2.51	.032	.026	46.8	32.5	.036	2.51	.024	.026	49.2	33.0	.044	3.62	.065	.038	44.8	.127	7.20	-----
25	42.0	36.3	.054	3.18	[4].077	.044	42.4	35.7	.051	3.18	.051	.042	43.6	34.6	.045	3.18	.041	.037	44.9	36.6	.064	4.61	.080	.063	[13]45.4	[13].133	[13]16.67	-----
[14]28	38.7	37.4	.084	2.38	.077	.060	38.4	36.7	.084	2.38	.068	.060	36.7	33.8	.070	2.38	.050	.050	38.6	34.7	.086	3.37	.087	.072	39.8	.116	6.20	-----
29	33.9	34.3	.075	.73	.043	.039	33.7	33.9	.076	.73	.037	.040	32.0	32.3	.074	.73	.039	.039	33.8	33.2	.080	1.39	.050	.048	37.8	.102	6.00	-----
30	43.9	37.7	.065	1.39	.023	.039	43.8	37.0	.062	1.39	.039	.037	41.6	34.2	.050	1.39	.024	.030	43.7	37.9	.089	2.13	.048	.062	48.1	.134	4.42	-----
1927																												
Apr. 6	51.4	50.3	.156	1.54	.075	.097	51.3	50.5	.172	1.54	.121	.107	52.6	53.0	.233	1.54	.164	.145	53.5	53.8	.253	2.36	.200	.182	50.7	.172	8.58	-----
7	53.0	52.5	.176	2.99	.121	.140	53.1	52.1	.200	2.99	.160	.159	55.1	55.5	.260	2.99	.200	.206	56.6	55.4	.278	4.46	.243	.268	52.5	.159	6.50	-----
8	50.5	52.3	.162	2.39	.110	.117	50.7	52.1	.189	2.39	.151	.137	52.3	53.1	.201	2.39	.182	.145	52.6	51.4	.190	3.44	.214	.161	50.1	.144	8.54	-----
9	51.6	54.8	.195	1.44	.087	.119	51.5	54.7	.200	1.44	.135	.122	52.3	54.7	.228	1.44	.156	.139	54.2	54.2	.246	2.23	.179	.173	51.2	.170	5.12	-----
10	44.9	53.9	.175	1.32	.094	.104	45.3	53.4	.172	1.32	.145	.103	46.4	52.7	.174	1.32	.100	.104	47.7	50.6	.156	2.05	.117	.106	44.1	.239	4.96	.467
11	38.4	52.1	.155	1.70	.063	.099	39.1	50.6	.142	1.70	.085	.091	36.8	46.2	.097	1.70	−.044	.062	37.9	40.7	.045	2.82	.025	.035	35.6	.182	7.67	.965
12	35.8	49.2	.160	[15]4.92	.071	.163	36.8	48.7	.158	[15]4.92	.068	.162	34.4	42.1	.098	[15]4.92	−.011	.100	35.4	39.5	.081	6.95	.009	.102	33.2	.150	12.75	.178
[16]18	49.4	49.7	.130	1.61	.053	.082	49.0	49.8	.140	1.61	.091	.088	49.5	51.5	.176	1.61	.118	.111	52.8	52.7	.218	2.38	.154	.157	46.3	.182	7.05	-----
19	39.0	48.0	.136	2.78	.086	.105	38.8	46.8	.130	2.78	.096	.100	38.5	43.9	.104	2.78	.092	.080	38.9	42.3	.096	3.84	.098	.086	34.4	.166	7.75	.007
20	35.2	46.8	.154	2.83	.108	.119	35.5	45.5	.144	2.83	.123	.112	34.3	42.1	.118	2.83	.105	.091	34.8	38.2	.087	3.98	.097	.079	35.4	.159	8.67	.008
21	36.4	47.3	.175	1.72	.092	.112	36.4	46.4	.176	1.72	.133	.113	36.8	44.1	.171	1.72	.116	.110	37.4	42.7	.156	2.36	.114	.112	33.1	.110	6.17	-----
22	43.9	49.2	.155	1.14	.062	.089	44.7	48.6	.152	1.14	.099	.087	45.6	47.9	.156	1.14	.102	.090	45.9	46.8	.164	1.77	.108	.106	40.4	.167	4.96	-----
23	46.3	49.6	.111	3.45	.091	.094	46.1	49.5	.111	3.45	.107	.094	45.2	49.1	.119	3.45	.101	.101	46.6	50.2	.145	4.74	.169	.145	48.0	.221	8.75	.215
24	47.7	52.6	.157	1.44	.070	.096	47.6	52.5	.159	1.44	.114	.097	48.8	53.5	.189	1.44	.126	.116	50.2	52.1	.198	2.14	.147	.137	45.2	.212	5.58	.004
25	57.1	57.0	.206	1.23	.074	.120	57.0	56.9	.208	1.23	.163	.122	58.7	58.3	.268	1.23	.169	.157	60.1	60.0	.319	1.85	.218	.209	54.6	.224	4.87	-----
26	61.8	58.3	.212	1.25	.085	.125	61.5	58.8	.226	1.25	.137	.133	63.5	60.6	.300	1.25	.178	.176	64.7	63.0	.371	1.90	.246	.246	60.6	.192	5.08	-----
27	60.4	58.9	.222	1.09	.085	.126	60.6	59.0	.229	1.09	.145	.130	61.4	60.2	.294	1.09	.165	.167	63.3	62.1	.333	1.61	.215	.210	61.5	.182	7.88	-----
28	57.7	57.9	.218	5.30	.227	.233	57.8	57.7	.215	5.30	.239	.230	56.5	57.6	.239	5.30	.265	.255	57.9	57.6	.243	7.77	.358	.330	55.8	.220	10.33	-----
29	55.8	58.6	.225	1.24	.089	.132	56.0	57.9	.224	1.24	.148	.131	56.7	57.8	.249	1.24	.144	.146	57.2	56.0	.230	1.77	.163	.149	53.7	.166	6.08	-----
30	59.3	59.8	.229	1.40	.098	.138	59.3	59.5	.230	1.40	.122	.139	61.3	60.0	.263	1.40	.158	.159	62.4	60.4	.276	2.06	.209	.189	58.2	.228	4.54	-----
May 1	61.9	62.0	.270	1.19	.117	.157	62.1	61.5	.278	1.19	.176	.161	62.5	61.8	.328	1.19	.175	.190	64.4	63.1	.380	1.70	.232	.244	58.5	.246	6.50	-----
2	62.8	61.0	.335	4.40	.282	.322	61.8	60.4	.328	4.40	.383	.315	61.6	60.1	.370	4.40	.375	.355	62.8	59.3	.373	5.78	.475	.419	62.5	.124	14.50	-----
3	51.3	60.2	.302	2.21	.194	.212	51.1	58.0	.295	2.21	.251	.206	51.8	56.0	.292	2.21	.238	.205	52.0	55.0	.298	2.93	.251	.234	47.4	.136	7.75	-----
4	59.5	60.4	.316	3.54	.242	.271	59.3	60.2	.313	3.54	.298	.269	58.9	58.2	.307	3.54	.264	.264	59.6	57.4	.314	4.58	.364	.308	55.4	.150	11.96	-----
5	53.5	60.4	.234	2.01	.116	.159	53.5	60.6	.246	2.01	.146	.167	52.8	57.5	.217	2.01	.137	.147	53.1	55.3	.188	2.62	.159	.141	50.4	.234	7.79	.012
6	57.0	61.8	.203	1.76	.099	.132	57.0	61.2	.201	1.76	.154	.130	58.0	60.7	.214	1.76	.151	.139	58.6	60.4	.236	2.48	.178	.173	57.2	.279	6.33	.002
7	61.3	64.4	.229	3.28	.188	.189	61.3	64.2	.237	3.28	.205	.196	62.4	64.8	.274	3.28	.272	.226	63.3	64.9	.310	4.76	.333	.311	64.2	.330	13.54	-----
8	42.8	57.4	.242	9.84	.381	.392	43.5	55.0	.206	9.84	[17].258	.334	42.1	49.1	.130	9.84	.284	.211	42.6	42.0	.065	14.48	.212	.140	44.4	.189	27.75	.693
9	41.1	51.1	.233	8.84	.351	.346	43.3	49.9	.219	8.84	.372	.325	42.9	45.7	.172	8.84	.226	.255	42.6	42.0	.147	12.10	.292	.275	42.6	.116	21.71	-----
10	57.6	52.6	.204	2.38	.119	.147	48.2	52.1	.199	2.38	.154	.143	48.2	52.7	.226	2.38	.150	.163	49.3	51.2	.232	3.32	.152	.193	44.6	.121	5.54	-----
11	54.4	55.9	.204	1.91	.101	.136	55.5	55.9	.210	1.91	.159	.140	57.3	58.1	.254	1.91	.192	.169	57.7	59.0	.292	2.72	.249	.222	50.6	.192	7.83	-----
12	57.3	56.0	.179	3.01	.113	.142	58.8	56.6	.200	3.01	.167	.159	58.7	58.2	.246	3.01	.190	.195	59.2	58.8	.268	4.24	.283	.252	56.6	.198	10.08	.100
13	59.2	58.2	.205	2.08	.105	.140	59.2	58.2	.213	2.08	.149	.146	60.5	60.5	.267	2.08	.173	.183	60.8	60.8	.284	3.04	.225	.227	59.3	.254	5.92	.002
14	56.5	60.0	.200	.80	.062	.107	57.6	59.6	.198	.80	.091	.106	56.3	61.4	.257	.80	.113	.137	56.6	60.4	.251	1.24	.139	.147	54.1	.278	4.25	.006
15	59.4	62.0	.229	1.22	.089	.134	60.9	61.5	.226	1.22	.155	.132	60.0	62.4	.266	1.22	.166	.155	60.9	62.8	.289	1.68	.206	.184	56.4	.264	5.21	.002
16	66.3	63.6	.263	1.25	.106	.154	68.1	63.4	.267	1.25	.172	.157	68.4	65.8	.326	1.25	.188	.191	69.7	66.6	.370	1.58	.257	.232	66.0	.250	5.67	-----

See footnotes at end of table.

TABLE 14.—*Evaporation from a circular reservoir and from standard tanks at Fort Collins, Colo. (elevation 5,000 feet, barometric pressure 24.990 inches), as observed and as computed from formula 10, and pertinent meteorological data*—Continued

Date	Reservoir						Geological Survey floating tank,						Colorado type land tank, class A						Weather Bureau land tank, class A						Other meteorological data			
	Meteorological data (mean values for 24 hours)				Evaporation in 24 hours		Meteorological data (mean values for 24 hours)				Evaporation in 24 hours		Meteorological data (mean values for 24 hours)				Evaporation in 24 hours		Meteorological data (mean values for 24 hours)				Evaporation in 24 hours					
	Temperature		Difference in vapor pressure, e_s-e_d	Velocity of wind at ground	Observed	Computed	Temperature		Difference in vapor pressure, e_s-e_d	Velocity of wind at ground	Observed	Computed	Temperature		Difference in vapor pressure, e_s-e_d	Velocity of wind at ground [1]	Observed	Computed	Temperature		Difference in vapor pressure, e_s-e_d	Velocity of wind at ground [1]	Observed	Computed	Daily mean air temperature [2]	Daily mean air vapor pressure [2]	Daily mean wind tower velocity [2]	Precipitation
	Air	Water					Air	Water					Air	Water					Air	Water								
1927	°F.	°F.	Inch of mercury	Miles per hour	Inch	Inch	°F.	°F.	Inch of mercury	Miles per hour	Inch	Inch	°F.	°F.	Inch of mercury	Miles per hour	Inch	Inch	°F.	°F.	Inch of mercury	Miles per hour	Inch	Inch	°F.	Inch of mercury	Miles per hour	Inch
May 17	68.6	64.0	0.292	2.56	0.187	0.217	69.6	63.7	0.304	2.56	0.251	0.226	70.2	65.6	0.348	2.56	0.260	0.258	70.7	65.4	0.366	3.56	0.358	0.315	65.6	0.232	11.00	-----
18	61.6	64.3	.316	1.40	.152	.191	61.8	63.7	.325	1.40	.254	.197	63.0	65.0	.376	1.40	.210	.227	63.6	64.6	.410	1.77	.251	.266	58.4	.176	5.08	-----
19	59.3	64.8	.279	1.97	.167	.188	60.3	64.5	.276	1.97	.152	.186	60.2	65.0	.296	1.97	.235	.199	60.8	63.2	.298	2.88	.274	.232	57.2	.311	7.13	-----
20	62.0	65.3	.306	1.90	.167	.203	62.9	65.1	.315	1.90	.219	.209	63.9	65.3	.329	1.90	.240	.218	64.0	63.2	.328	2.64	.277	.247	58.0	.272	8.04	-----
21	63.8	67.6	.308	1.74	.146	.199	65.8	66.8	.289	1.74	.206	.186	65.0	68.0	.344	1.74	.220	.222	65.6	66.8	.354	2.50	.269	.260	62.0	.309	5.92	-----
22	62.5	67.3	.310	1.90	.192	.206	64.0	66.1	.298	1.90	.234	.198	64.4	66.4	.341	1.90	.260	.226	63.6	63.8	.307	2.65	.272	.231	61.4	.188	7.42	0.004
23	57.4	65.8	.413	2.60	.271	.308	59.2	63.9	.411	2.60	.337	.307	58.0	62.3	.377	2.60	.283	.282	57.6	56.0	.288	3.28	.316	.238	53.4	.166	14.38	-----
24	60.6	63.7	[18].381	3.70	.299	.334	61.7	62.8	[18].368	3.70	.398	.323	61.4	61.7	.365	3.70	.300	.320	61.0	58.9	.350	4.95	.382	.359	61.0	.147	10.33	-----
25	62.3	66.0	[18].362	.87	.130	.197	62.8	64.8	[18].338	.87	.197	.184	63.3	66.6	.405	.87	.204	.220	64.1	64.8	.379	1.03	.225	.213	58.0	.258	5.21	-----
26	65.5	67.1	.370	1.73	.198	.238	65.9	65.9	.367	1.73	.262	.236	66.7	67.6	.445	1.73	.274	.287	66.8	66.4	.442	2.34	.347	.316	61.0	.204	8.67	-----
27	64.2	66.3	.360	1.43	.180	.219	64.1	65.6	.356	1.43	.228	.217	63.8	66.0	.390	1.43	.240	.238	65.0	64.4	.386	1.86	.249	.254	59.7	.229	6.08	-----
28	63.2	68.0	.350	1.65	.197	.222	63.2	67.6	.339	1.65	.237	.215	63.8	68.4	.394	1.65	.260	.250	64.2	67.8	.378	2.17	.305	.263	62.4	.256	8.38	-----
29	55.6	65.2	.410	3.02	.357	.326	57.8	64.2	.396	3.02	.482	.315	56.5	63.2	.431	3.02	.354	.343	56.6	58.0	.354	3.64	.372	.308	54.6	.104	10.89	-----
30	56.6	65.6	.352	1.01	.155	.197	56.2	64.6	.334	1.01	.205	.187	58.0	63.5	.360	1.01	.191	.201	57.3	59.2	.306	1.34	.178	.183	50.5	.224	6.62	.006
31	53.9	63.9	.233	.96	.104	.129	54.1	62.4	.204	.96	.134	.113	53.3	60.2	.186	.96	.088	.103	53.1	55.5	.116	.93	.105	.064	51.5	.346	6.12	.124
June 1	59.5	65.6	.245	1.00	.097	.137	60.0	65.0	.242	1.00	.137	.135	60.6	64.6	.253	1.00	.133	.141	61.0	64.1	.256	1.50	.133	.158	58.1	.332	4.17	.004
2	57.4	64.2	.241	.72	.096	.126	57.6	63.4	.237	.72	.117	.124	58.2	62.4	.222	.72	.112	.117	58.8	60.4	.180	.82	.111	.097	55.2	.330	5.88	-----
3	58.0	64.4	.253	1.67	.135	.161	57.8	63.8	.243	1.67	.175	.155	57.6	62.8	.241	1.67	.147	.154	57.7	59.8	.202	2.51	.194	.149	57.8	.306	6.17	.310
[19] 5	55.5	64.5	.210	.64	.080	.168	55.3	63.8	.196	.64	.117	.101	54.8	62.2	.186	.64	.146	.096	55.5	59.7	.149	.72	.122	.078	53.0	.346	4.29	.751
6	62.3	67.8	.235	.39	.070	.114	62.8	67.3	.254	.39	.119	.123	61.5	67.3	.300	.39	.119	.146	62.7	67.8	.317	.49	.140	.158	61.6	.396	3.00	.016
7	65.8	70.5	.292	.42	.089	.143	66.3	69.6	.291	.42	.144	.142	65.9	71.3	.350	.42	.173	.171	67.5	71.7	.370	.59	.209	.189	64.1	.404	3.00	-----
8	68.0	70.0	.283	.92	.107	.155	69.2	69.2	.272	.92	.160	.149	68.9	70.1	.314	.92	.182	.172	69.6	69.5	.314	1.29	.214	.185	66.5	.396	8.46	-----
9	68.8	71.2	.410	1.94	.221	.274	68.6	69.9	.395	1.94	.285	.264	70.3	71.1	.457	1.94	.294	.306	71.4	72.0	.503	2.76	.342	.386	71.2	.289	4.67	-----
10	65.6	70.7	[20].335	.82	.124	.180	65.7	70.3	[20].338	.82	.166	.181	65.2	69.9	[20].349	.82	.190	.187	65.7	68.8	[20].333	1.15	.222	.192	65.7	.342	3.58	.037
11	61.9	70.3	[20].324	1.39	.148	.196	61.4	69.6	[20].328	1.39	.155	.198	62.8	69.5	[20].337	1.39	.199	.204	62.5	66.2	[20].272	1.98	.204	.183	64.7	.360	7.25	.032

	12	51.8	67.9	.310	.74	.133	.163	51.2	65.9	.276	.74	.126	.145	49.8	60.6	.189	.74	.062	.099	49.7	54.6	.091	.91	.046	.050	47.6	.312	5.37	.206
	13	49.9	65.1	.286	.62	.124	.147	49.3	63.6	.264	.62	.135	.135	46.4	55.8	.161	.62	.058	.083	46.7	50.1	.080	.90	.032	.044	46.2	.274	5.12	.068
	14	53.7	63.6	.206	.72	.074	.108	53.0	62.4	.195	.72	.088	.102	51.2	56.1	.104	.72	.041	.055	51.9	53.4	.065	1.07	.027	.037	51.0	.346	2.96	.132
	15	57.6	63.6	.206	2.80	.153	.158	58.1	63.3	.216	2.80	.157	.166	55.9	60.0	.186	2.80	.150	.143	56.4	59.3	.181	4.18	.204	.169	57.9	.315	8.08	.007
	16	58.9	65.3	.258	.79	.082	.138	59.2	65.0	.256	.79	.136	.137	60.0	64.2	.249	.79	.134	.133	60.8	64.8	.255	1.18	.149	.148	55.0	.364	4.54	.060
	17	63.7	67.0	.230	1.51	.096	.142	64.8	66.9	.231	1.51	.155	.143	66.4	67.3	.248	1.51	.163	.153	66.5	67.8	.271	2.26	.217	.192	62.6	.374	7.58	-----
	18	67.6	67.6	.250	1.79	.093	.163	68.1	67.6	.262	1.79	.156	.171	67.8	67.8	.291	1.79	.166	.189	68.6	68.7	.321	2.65	.210	.241	67.7	.396	6.92	.037
	19	64.9	68.1	.204	1.04	.090	.115	64.8	67.7	.208	1.04	.120	.117	65.4	67.4	.235	1.04	.120	.132	65.5	66.3	.232	1.59	.140	.146	62.6	.372	4.25	-----
	20	65.6	68.5	.320	2.77	.227	.245	65.4	67.9	.296	2.77	.235	.227	66.4	67.7	.344	2.77	.302	.264	67.2	66.0	.296	4.32	.378	.281	65.0	.313	7.83	-----
	21	59.6	68.5	.333	1.01	.119	.186	60.8	67.4	.314	1.01	.140	.176	60.2	66.8	.352	1.01	.188	.197	60.2	63.3	.273	1.53	.216	.170	56.8	.350	4.21	.146
	22	60.3	69.2	.342	1.02	.139	.192	61.5	68.7	.345	1.02	.226	.193	61.3	67.4	.354	1.02	.197	.198	62.0	65.6	.334	1.48	.207	.205	54.4	.324	5.33	-----
	23	69.6	71.7	.353	.91	.134	.193	70.0	71.0	.355	.91	.203	.194	70.0	70.3	.368	.91	.238	.201	70.8	70.7	.411	1.52	.282	.255	68.3	.344	4.75	-----
	24	74.1	73.0	.356	.74	.117	.188	74.8	72.5	.383	.74	.179	.202	74.5	71.9	.401	.74	.193	.211	75.6	72.8	.456	1.14	.243	.262	73.4	.400	4.50	-----
	25	69.2	72.5	.246	1.89	.112	.163	69.2	72.0	.250	1.89	.137	.166	68.8	70.8	.268	1.89	.178	.178	69.8	71.5	.286	2.86	.272	.222	68.6	.487	9.42	.309
	26	73.8	74.8	.329	1.54	.164	.205	73.8	74.1	.338	1.54	.241	.210	72.8	73.0	.350	1.54	.217	.218	74.3	74.6	.386	2.36	.291	.278	73.8	.419	4.75	-----
	27	72.6	75.4	.320	.78	.117	.170	73.4	74.6	.338	.78	.152	.180	73.4	75.2	.412	.78	.197	.219	74.7	76.2	.440	1.29	.258	.260	73.0	.442	4.13	.005
	28	69.4	75.1	.305	1.02	.116	.171	69.6	71.7	.227	1.02	.133	.127	69.7	74.3	.326	1.02	.181	.183	70.1	71.8	.270	1.66	.207	.172	71.3	.514	3.62	.040
	29	65.8	74.7	.328	.89	.141	.179	65.9	73.8	.318	.89	.183	.173	65.4	71.8	.296	.89	.182	.161	66.0	66.6	.167	1.48	.181	.103	66.7	.388	4.13	.030
	30	65.5	73.7	.416	1.46	.214	.254	66.1	73.2	.410	1.46	.191	.251	65.3	69.8	.353	1.46	.207	.216	64.9	67.3	.296	2.30	.228	.211	64.6	.379	7.00	-----
July	1	65.5	73.3	.359	.90	.142	.196	65.8	72.2	.347	.90	.215	.190	66.6	70.1	.316	.90	.167	.173	67.0	69.4	.324	1.40	.180	.196	61.0	.413	5.17	-----
	2	71.2	74.9	.382	1.41	.183	.232	71.5	74.6	.400	1.41	.221	.242	72.8	73.9	.394	1.41	.279	.239	72.8	74.4	.443	2.27	.319	.313	68.1	.331	5.33	-----
	3	71.9	75.2	.383	.93	.175	.211	72.6	75.1	.410	.93	.303	.226	73.2	74.7	.418	.93	.273	.230	74.5	73.3	.409	1.59	.307	.257	68.8	.353	5.17	-----
	4	72.8	75.8	.430	1.69	.208	.275	72.9	74.7	.418	1.69	.289	.267	74.2	74.2	.428	1.69	.308	.273	75.1	72.7	.414	2.69	.351	.314	71.6	.416	6.67	-----
	5	73.4	76.1	.472	.95	.198	.261	74.4	75.2	.478	.95	.245	.264	73.8	74.7	.511	.95	.263	.282	74.6	73.4	.524	1.55	.300	.327	69.0	.382	4.54	-----
	6	72.8	77.0	.488	.79	.186	.260	73.7	76.3	.498	.79	.269	.265	74.0	76.7	.563	.79	.288	.300	75.0	75.2	.530	1.29	.314	.314	69.0	.396	4.63	-----
	7	73.4	77.3	.449	.82	.174	.241	74.2	76.7	.454	.82	.232	.244	74.2	76.2	.483	.82	.255	.259	74.6	75.3	.467	1.37	.282	.281	70.4	.400	4.33	-----
	8	73.3	78.0	.471	.83	.186	.253	73.5	77.3	.484	.83	.272	.260	74.4	76.8	.530	.83	.277	.286	75.2	76.2	.537	1.31	.318	.319	70.6	.370	5.33	-----
	9	71.3	77.5	.438	1.72	.218	.281	71.6	76.2	.424	1.72	.261	.273	73.1	75.5	.450	1.72	.264	.289	72.9	71.8	.362	2.86	.261	.282	71.6	.418	5.33	.033
	10	72.9	76.5	.381	1.24	.168	.220	73.9	76.6	.407	1.24	.196	.235	72.8	75.2	.434	1.24	.233	.250	72.8	74.2	.432	1.78	.255	.281	71.2	.452	4.92	-----
	11	72.3	77.4	.420	.74	.157	.221	72.5	76.6	.434	.74	.202	.229	73.5	76.0	.477	.74	.241	.251	73.9	74.9	.470	1.21	.300	.274	68.9	.407	4.00	.130
	12	72.4	77.6	.394	.82	.120	.211	72.6	76.9	.389	.82	.160	.209	69.3	75.3	.355	.82	.182	.191	69.9	74.4	.368	1.35	.226	.220	69.5	.473	5.00	.118
	13	67.2	77.0	.413	1.23	.188	.242	67.6	76.1	.390	1.23	.203	.228	66.0	73.4	.341	1.23	.200	.200	66.5	71.2	.306	2.02	.243	.208	67.0	.404	4.25	.227
	14	65.8	76.1	.368	.73	.142	.194	64.9	75.2	.354	.73	.188	.186	64.7	71.4	.282	.73	.152	.148	64.6	69.8	.274	1.19	.168	.159	63.0	.441	4.08	.082
	15	70.5	77.1	.430	1.29	.199	.255	70.5	76.3	.425	1.29	.234	.252	70.6	74.0	.432	1.29	.223	.256	71.6	73.1	.421	2.03	.272	.287	67.4	.378	8.67	-----
	16	66.7	75.1	.447	1.96	.268	.300	66.8	72.9	.416	1.96	.338	.279	67.0	72.3	.445	1.96	.300	.298	67.2	70.4	.410	2.92	.268	.322	64.6	.354	5.21	-----
	17	71.9	76.7	.437	.92	.158	.240	72.1	72.5	.343	.92	.213	.188	73.2	75.6	.449	.92	.226	.246	74.9	74.9	.455	1.63	.254	.288	69.3	.370	4.50	-----
	18	72.7	76.4	.385	1.08	.156	.218	72.9	74.8	.352	1.08	.189	.199	73.8	75.8	.403	1.08	.222	.228	74.2	75.6	.412	1.82	.244	.270	73.6	.503	4.08	-----
	[21] 21	68.5	73.6	.282	.63	.095	.145	68.4	72.8	.277	.63	.114	.142	68.4	71.4	.270	.63	.116	.139	69.2	69.9	.241	1.04	.131	.136	68.8	.492	3.62	.119
	22	68.1	74.8	.300	.96	.113	.166	68.3	74.1	.295	.96	.170	.163	68.2	73.1	.312	.96	.169	.172	69.0	73.1	.319	1.37	.187	.192	65.5	.498	5.12	.005
	23	69.0	75.2	.330	.99	.138	.184	69.1	74.3	.318	.99	.169	.177	69.5	74.1	.343	.99	.206	.191	70.2	73.4	.322	1.59	.235	.202	68.6	.450	4.96	.120
	24	67.9	75.7	.383	.74	.139	.202	68.7	74.4	.373	.74	.200	.197	70.4	73.9	.379	.74	.190	.200	69.1	72.7	.392	1.21	.197	.228	65.8	.411	3.96	.006
	25	70.0	76.7	.439	.72	.166	.230	70.4	74.3	.393	.72	.238	.206	70.2	74.8	.454	.72	.236	.238	71.0	74.2	.462	1.13	.245	.265	65.2	.381	3.71	-----
	26	70.7	75.5	.357	.57	.137	.181	71.0	72.4	.304	.57	.157	.154	69.2	71.2	.302	.57	.129	.153	70.0	68.9	.255	.97	.136	.142	65.0	.470	4.46	.091
	27	72.3	75.9	.356	.63	.122	.183	72.3	73.8	.304	.63	.172	.156	73.0	73.2	.333	.63	.143	.170	73.0	72.9	.350	1.17	.157	.203	69.4	.420	2.83	.005
	28	65.6	74.3	.264	1.21	.116	.154	66.0	73.5	.244	1.21	.136	.242	74.8	70.8	.204	1.21	.109	.119	64.8	69.4	.173	1.92	.129	.115	66.0	.526	6.25	.314
	29	64.0	73.1	.262	.80	[22] .116	.140	64.6	71.8	.234	.80	[22] .116	.125	63.0	67.7	.183	.80	[22] .092	.098	63.7	65.0	.118	1.21	[22] .074	.069	63.0	.472	3.17	.127
	30	66.9	73.7	.347	.62	.109	.177	67.7	72.8	.326	.62	.157	.167	65.7	67.8	.228	.62	.097	.117	67.5	69.7	.303	1.09	.125	.172	61.5	.453	3.75	.012
	31	66.6	74.0	.347	1.18	.147	.201	66.6	72.9	.324	1.18	.188	.187	67.4	70.4	.296	1.18	.166	.171	68.2	71.6	.347	1.04	.199	.226	63.4	.417	3.92	.015
Aug.	1	63.6	72.5	.266	.84	.120	.143	63.4	71.3	.234	.84	.121	.126	62.5	67.7	.184	.84	.084	.099	62.8	65.8	.137	1.41	.077	.083	61.9	.466	4.58	.012
	2	59.3	70.6	.251	1.23	.126	.147	58.8	68.8	.211	1.23	.123	.123	58.0	64.3	.148	1.23	.066	.087	58.0	60.8	.072	1.81	.044	.047	56.2	.438	3.92	.139
	3	63.5	70.9	.240	1.02	.089	.134	63.4	70.0	.231	1.02	.123	.129	62.0	67.6	.199	1.02	.102	.111	62.9	66.7	.186	1.50	.115	.115	64.0	.464	4.75	.023

See footnotes at end of table.

TABLE 14.—*Evaporation from a circular reservoir and from standard tanks at Fort Collins, Colo. (elevation 5,000 feet, barometric pressure 24.990 inches), as observed and as computed from formula 10, and pertinent meteorological data*—Continued

Date	Reservoir						Geological Survey floating tank						Colorado type land tank, class A						Weather Bureau land tank, class A						Other meteorological data			
	Meteorological data (mean values for 24 hours)				Evaporation in 24 hours		Meteorological data (mean values for 24 hours)				Evaporation in 24 hours		Meteorological data (mean values for 24 hours)				Evaporation in 24 hours		Meteorological data (mean values for 24 hours)				Evaporation in 24 hours					
	Temperature						Temperature						Temperature						Temperature									
	Air	Water	Difference in vapor pressure, $e_s - e_d$	Velocity of wind at ground	Observed	Computed	Air	Water	Difference in vapor pressure, $e_s - e_d$	Velocity of wind at ground	Observed	Computed	Air	Water	Difference in vapor pressure, $e_s - e_d$	Velocity of wind at ground	Observed	Computed	Air	Water	Difference in vapor pressure, $e_s - e_d$	Velocity of wind at ground [1]	Observed	Computed	Daily mean air temperature [2]	Daily mean air vapor pressure [2]	Daily mean wind tower velocity [2]	Precipitation
1927	°F.	°F.	Inch of mercury	Miles per hour	Inch	Inch	°F.	°F.	Inch of mercury	Miles per hour	Inch	Inch	°F.	°F.	Inch of mercury	Miles per hour	Inch	Inch	°F.	°F.	Inch of mercury	Miles per hour	Inch	Inch	°F.	Inch of mercury	Miles per hour	Inch
Aug. 4	65.2	72.7	0.303	0.98	0.108	0.169	65.1	71.6	0.283	0.98	0.126	0.157	65.6	71.2	0.295	0.98	0.336	0.164	66.2	70.0	0.300	1.49	0.370	0.185	63.6	0.433	4.54	0.541
5	69.0	73.5	.340	.68	.111	.177	69.2	73.0	.349	.68	.162	.181	69.2	72.5	.348	.68	.197	.181	70.1	71.4	.360	1.16	.191	.208	68.4	.443	3.46	-----
6	68.3	72.5	.289	.82	.098	.155	68.3	73.1	.280	.82	.121	.150	68.2	72.3	.290	.82	.146	.156	68.6	71.7	.284	1.37	.161	.171	69.4	.467	2.87	.079
7	66.6	70.9	.310	1.11	.130	.177	66.4	72.6	.303	1.11	.165	.173	66.6	71.6	.293	1.11	.159	.167	66.4	69.7	.252	1.72	.172	.162	67.4	.468	4.33	.008
8	62.2	71.6	.305	.93	.123	.168	62.1	70.0	.285	.93	.146	.157	61.4	66.9	.248	.93	.113	.136	62.2	62.8	.160	1.51	.090	.099	57.8	.393	4.17	.038
9	65.4	72.4	.322	1.00	.118	.180	65.4	71.2	.315	1.00	.169	.176	65.4	69.6	.315	1.00	.150	.176	66.1	68.0	.299	1.56	.153	.187	63.4	.394	3.96	-----
10	67.4	72.6	.349	1.00	.129	.195	67.1	71.1	.322	1.00	.178	.180	67.0	70.5	.346	1.00	.173	.193	69.0	70.1	.342	1.55	.201	.213	64.3	.394	5.21	-----
11	69.0	72.1	.315	1.10	.131	.180	68.8	71.5	.317	1.10	.178	.181	68.3	69.8	.324	1.10	.161	.185	68.9	69.0	.306	1.84	.180	.201	67.8	.424	3.75	-----
12	66.1	71.8	.306	.93	[22] .120	.168	67.2	71.2	.310	.93	[22] .135	.171	65.4	69.3	.300	.93	[22] .147	.165	66.8	67.5	.253	1.50	[22] .131	.156	65.2	.408	4.38	-----
13	68.2	72.8	.303	.73	.095	.159	68.1	72.0	.297	.73	.136	.156	68.7	70.8	.290	.73	.160	.152	70.1	69.5	.263	1.17	.157	.152	64.2	.478	3.88	.119
14	66.6	73.0	.268	.87	.103	.145	66.8	72.3	.255	.87	.141	.138	68.0	71.8	.275	.87	.141	.149	68.0	70.8	.257	1.41	.144	.156	63.2	.474	4.13	-----
15	68.8	72.3	.298	1.32	.145	.178	69.0	71.9	.290	1.32	.194	.173	69.6	70.9	.290	1.32	.200	.173	70.6	69.6	.282	2.13	.226	.195	66.4	.408	5.62	-----
16	63.6	72.1	.350	.98	.132	.195	63.1	71.9	.352	.98	.183	.196	62.8	69.9	.356	.98	.172	.198	63.7	67.6	.321	1.57	.175	.201	60.2	.372	3.71	.035
17	66.1	72.9	.402	.66	.152	.208	66.7	72.7	.414	.66	.211	.214	66.7	70.6	.395	.66	.201	.205	67.0	68.4	.362	1.04	.210	.204	61.9	.326	3.12	-----
18	61.7	72.1	.347	.90	.152	.189	60.8	70.5	.329	.90	.189	.180	60.9	68.5	[23] .337	.90	.162	.184	61.7	65.9	[23] .248	1.29	.148	.147	59.6	.362	4.83	-----
19	64.2	72.3	.361	.68	.126	.188	63.6	71.6	.347	.68	.173	.180	64.9	70.0	.337	.68	.173	.175	66.0	68.3	.311	1.16	.168	.180	60.4	.378	2.88	-----
20	66.9	72.4	.359	.87	[22] .132	.195	66.2	72.2	.349	.87	[22] .185	.190	67.8	69.9	.346	.87	[22] .188	.188	66.8	69.0	.320	1.47	[22] .195	.196	65.8	.387	3.33	-----
21	69.2	73.1	.367	1.07	.163	.208	70.4	72.2	.341	1.07	.220	.193	69.6	70.2	.332	1.07	.214	.188	71.0	68.0	.304	1.73	.224	.196	64.5	.350	4.58	.004
22	64.9	72.0	.297	.93	.107	.163	65.4	71.3	.289	.93	.132	.159	65.0	68.3	.235	.93	.136	.129	64.8	66.2	.195	1.47	.146	.120	63.6	.422	4.37	.270
23	61.0	70.7	.231	.93	.104	.127	60.7	69.6	.210	.93	.118	.116	59.4	65.0	.142	.93	.097	.078	59.9	62.5	.094	1.47	.067	.058	60.0	.465	4.04	.099
24	67.7	72.1	.309	.87	.106	.168	69.7	71.6	.341	.87	.159	.185	66.4	69.6	.325	.87	.155	.176	67.6	69.1	.323	1.34	.144	.193	65.1	.406	3.88	-----
25	66.9	71.9	.322	.98	.119	.179	67.7	71.3	.316	.98	.158	.176	67.4	69.7	.325	.98	.152	.181	68.0	68.9	.304	1.53	.163	.189	67.2	.392	4.33	-----
26	66.9	71.7	.325	.83	.107	.175	66.2	71.0	.301	.83	.147	.162	65.9	69.6	.313	.83	.140	.168	66.9	67.8	.274	1.33	.144	.163	65.9	.438	3.75	.002
27	66.4	71.7	.334	.93	.128	.184	66.0	71.1	.332	.93	.183	.183	67.0	70.0	.334	.93	.176	.184	67.8	69.1	.330	1.41	.195	.200	62.8	.360	4.25	-----
28	69.0	72.5	.307	.75	.098	.162	69.0	72.2	.320	.75	.159	.169	69.2	71.2	.327	.75	.180	.173	70.5	72.1	.349	1.24	.187	.204	67.2	.458	3.54	.024

29	68.0	73.9	.290	.58	.100	.153	68.0	73.8	.292	.58	.154	.154	67.4	73.3	.320	.58	.128	.169	68.5	73.7	.322	.99	.171	.179	68.2	.436	2.75	.004
30	67.6	74.5	.348	.72	.125	.183	68.0	74.1	.346	.72	.187	.182	67.6	73.7	.399	.72	.194	.209	69.6	73.4	.415	1.19	.202	.241	66.6	.455	3.29	.001
31	66.7	73.5	.370	1.02	.145	.207	66.1	72.8	.360	1.02	.192	.202	63.2	70.8	.349	1.02	.209	.195	65.6	68.6	.317	1.49	.224	.195	65.0	.360	5.17	.123
Sept. 1	67.8	73.6	.424	.67	.151	.220	67.7	72.8	.428	.67	.206	.222	66.4	69.4	.373	.67	.172	.194	68.6	67.8	.343	1.09	.165	.195	66.0	.300	4.21	-----
2	68.1	72.9	.404	.90	.170	.221	67.8	72.3	.432	.90	.245	.236	66.8	69.3	.384	.90	.219	.210	69.2	68.8	.409	1.50	.242	.252	65.4	.300	4.42	-----
3	66.2	72.8	.404	1.34	.179	.242	66.1	72.0	.392	1.34	.224	.234	65.7	70.2	.353	1.34	.232	.211	66.8	68.9	.361	2.03	.250	.245	65.6	.318	5.92	-----
4	66.6	73.1	.376	1.00	.149	.210	67.1	72.1	.363	1.00	.175	.203	66.6	70.2	.370	1.00	.228	.207	67.4	68.1	.313	1.67	.258	.199	66.8	.341	4.50	.194
5	66.2	72.6	.348	.60	.117	.178	66.4	71.8	.354	.60	.162	.181	64.8	69.3	.310	.60	.137	.158	65.8	68.2	.291	1.08	.141	.165	67.3	.420	3.12	-----
6	65.4	72.5	.355	.62	.119	.182	65.3	71.7	.353	.62	.164	.181	63.9	68.9	.303	.62	.142	.157	65.8	67.4	.274	1.01	.167	.153	63.5	.369	3.50	.017
7	67.0	72.5	.334	1.10	.132	.190	67.1	71.9	.340	1.10	.187	.194	67.2	69.8	.299	1.10	.163	.170	68.4	69.5	.311	1.67	.154	.198	66.5	.380	5.12	.002
8	66.0	71.4	.317	.48	.112	.158	65.8	70.6	.310	.48	.138	.154	64.4	67.6	.262	.48	.117	.130	66.1	65.7	.226	.93	.142	.124	66.2	.403	2.92	-----
9	69.7	72.7	.303	1.00	.101	.169	69.4	72.4	.294	1.00	.146	.164	69.6	71.0	.290	1.00	.154	.162	71.2	71.3	.311	1.85	.194	.204	70.1	.480	3.92	-----
10	69.6	73.6	.283	.67	.125	.147	69.8	73.3	.286	.67	.175	.148	69.6	72.7	.312	.67	.176	.162	71.6	72.4	.322	1.10	.185	.183	69.0	.464	3.25	.030
11	69.1	72.9	.334	.80	.126	.178	68.0	72.2	.325	.80	.180	.174	68.2	71.4	.343	.80	.178	.183	69.1	70.7	.313	1.22	.179	.183	68.7	.400	5.54	-----
12	68.8	73.0	.366	1.23	.158	.214	68.5	72.4	.374	1.23	.217	.219	68.9	71.0	.384	1.23	.215	.225	69.8	70.2	.375	1.96	.227	.252	68.4	.358	4.96	-----
13	68.3	72.8	.376	1.29	.168	.223	68.4	72.2	.354	1.29	.229	.210	68.2	70.5	.372	1.29	.214	.220	69.4	69.5	.342	2.13	.241	.236	69.4	.312	5.33	-----
14	65.4	71.6	.415	1.32	.192	.247	65.4	70.7	.402	1.32	.258	.240	64.3	68.2	.379	1.32	.244	.226	65.9	65.8	.342	2.08	.243	.234	63.7	.266	7.04	-----
15	64.9	70.9	.378	1.42	.182	.230	64.9	70.0	.347	1.42	.231	.211	64.6	68.0	.355	1.42	.236	.216	65.2	66.6	.327	2.35	.219	.235	64.9	.278	3.96	-----
16	66.4	71.7	.348	.63	.123	.179	67.0	70.7	.330	.63	.167	.170	66.6	69.3	.333	.63	.172	.171	67.7	68.6	.339	1.08	.180	.192	65.0	.350	3.46	-----
17	67.7	71.2	.343	1.18	.114	.199	68.6	70.2	.325	1.18	.155	.188	67.9	68.1	.292	1.18	.145	.169	68.4	67.0	.285	1.96	.183	.191	67.8	.364	4.87	.032
18	59.3	69.2	.394	.79	.171	.210	58.5	68.5	.374	.79	.207	.199	57.8	64.0	.331	.79	.187	.176	58.6	62.0	.295	1.27	.137	.174	57.3	.271	3.37	-----
19	57.9	68.1	.370	.87	.168	.201	57.0	67.3	.360	.87	.220	.195	56.8	64.2	.344	.87	.197	.187	57.2	60.6	.290	1.35	.170	.174	55.3	.191	4.08	-----
20	55.0	66.7	.371	.91	.176	.203	54.2	65.6	.364	.91	.220	.199	54.0	61.9	.326	.91	.175	.178	53.8	58.1	.264	1.28	.162	.156	49.2	.215	5.21	-----
21	58.7	66.4	.332	.88	.149	.181	57.5	65.4	.252	.88	.186	.192	58.3	62.0	.329	.88	.163	.179	57.6	59.3	.276	1.43	.158	.168	52.1	.231	4.21	-----
22	56.1	65.1	.308	.92	.117	.169	56.5	63.3	.272	.92	.142	.149	55.9	60.0	.250	.92	.121	.137	56.4	56.6	.198	1.48	.119	.122	52.6	.296	3.25	.066
23	56.8	64.7	.258	.74	.111	.136	57.0	62.9	.232	.74	.149	.122	57.4	60.9	.220	.74	.116	.116	57.6	58.5	.183	1.18	.111	.106	55.2	.277	3.87	.004
24	54.7	63.7	.222	1.18	.088	.129	55.7	61.7	.186	1.18	.131	.108	55.8	59.1	.172	1.18	.091	.100	55.0	56.8	.147	1.98	.113	.099	54.7	.332	6.67	.197
25	45.0	61.2	.259	1.55	.117	.161	45.6	58.9	.222	1.55	.059	.138	41.8	53.1	.168	1.55	.051	.105	41.8	46.2	.081	2.32	.039	.058	39.1	.216	3.88	.322
26	39.0	57.3	.311	.72	.125	.163	35.9	54.7	.232	.72	.138	.122	33.3	45.6	.130	.72	.055	.068	32.8	35.6	.035	1.05	.025	.020	31.5	.168	3.79	.055
27	45.5	56.4	.183	.88	.082	.100	44.0	55.4	.185	.88	.111	.101	42.6	49.6	.132	.88	.064	.072	43.3	46.5	.115	1.31	.055	.068	44.4	.210	3.50	-----
28	45.8	55.2	.163	1.04	.065	.092	45.1	53.5	.143	1.04	.073	.081	42.9	47.5	.083	1.04	.044	.047	43.8	44.2	.051	1.85	.038	.034	43.6	.209	6.75	.012
29	50.3	54.6	.218	1.83	.120	.143	50.2	54.0	.214	1.83	.146	.140	48.2	50.9	.200	1.83	.111	.131	50.3	50.8	.200	2.89	.116	.156	52.6	.173	5.96	-----
30	43.4	53.4	.154	1.40	.063	.093	43.8	52.4	.137	1.40	.083	.083	42.2	48.4	.105	1.40	.034	.064	42.7	46.2	.085	2.44	.066	.062	43.9	.231	4.75	.449
Oct. 1	44.9	53.6	.157	2.11	.098	.108	45.1	52.8	.152	2.11	.103	.105	44.5	50.5	.131	2.11	.099	.090	44.4	47.3	.105	3.44	.113	.089	44.6	.214	6.04	.060
2	41.6	52.1	.180	1.73	.105	.116	42.8	51.1	.167	1.73	.123	.108	41.0	47.0	.133	1.73	.095	.086	41.4	42.7	.101	2.77	.086	.078	42.1	.148	7.04	.005
3	46.8	53.0	.191	1.00	.067	.107	46.3	52.8	.188	1.00	.106	.105	45.1	50.8	.186	1.00	.096	.104	46.4	49.4	.178	1.52	.087	.110	46.4	.196	4.38	-----
4	52.3	55.0	.187	.92	.065	.103	52.7	55.4	.203	.92	.106	.111	52.1	54.4	.215	.92	.109	.118	53.7	55.2	.253	1.55	.128	.157	52.7	.192	4.42	-----
5	47.9	54.3	.193	.91	.073	.106	47.7	54.2	.202	.91	.108	.110	47.9	53.5	.209	.91	.107	.114	48.7	53.8	.212	1.39	.121	.128	44.8	.198	4.63	-----
6	43.8	53.9	.160	1.17	.060	.093	43.6	52.9	.152	1.17	.086	.088	43.2	51.2	.141	1.17	.067	.082	43.4	48.2	.112	1.83	.101	.074	41.2	.204	3.38	.535
7	45.5	54.1	.158	.72	.062	.083	44.9	53.7	.156	.72	.089	.082	53.2	51.7	.151	.72	.077	.079	43.8	49.3	.118	1.20	.070	.069	43.8	.217	3.38	.007
8	46.4	54.5	.202	.67	.074	.105	45.0	54.1	.205	.67	.105	.106	43.5	52.4	.202	.67	.095	.105	44.9	50.7	.192	1.09	.088	.109	46.2	.183	3.50	-----
9	46.2	55.2	.218	.55	.065	.110	45.4	55.0	.213	.55	.101	.108	45.7	53.1	.196	.55	.091	.099	47.0	52.2	.210	.93	.093	.115	48.6	.203	3.25	-----
10	51.2	53.7	.218	3.43	.165	.184	51.4	52.7	.214	3.43	.223	.180	50.2	50.5	.217	3.43	.166	.183	51.4	49.4	.218	4.19	.218	.204	52.4	.142	17.50	-----
11	44.3	51.2	.248	5.05	.246	.257	44.7	49.9	.228	5.05	.266	.236	43.7	46.6	.195	5.05	.209	.202	44.3	42.4	.160	7.47	.261	.212	45.9	.084	14.83	-----
12	43.2	50.6	.198	1.30	.085	.118	43.5	50.2	.195	1.30	.138	.116	42.3	47.4	.175	1.30	.107	.104	43.0	45.5	.175	1.84	.111	.115	43.4	.140	4.38	-----
13	47.6	52.6	.198	.71	.058	.104	47.3	52.8	.185	.71	.101	.097	46.9	51.5	.194	.71	.094	.102	48.0	51.8	.215	1.15	.111	.124	50.8	.176	3.96	-----
14	48.8	52.4	.168	.55	.052	.088	49.4	52.5	.165	.55	.083	.087	46.6	51.5	.189	.55	.079	.099	48.7	52.4	.204	.96	.103	.113	53.5	.196	2.96	-----
15	48.0	53.1	.173	.75	.058	.092	48.1	52.9	.174	.75	.088	.092	47.6	53.2	.198	.75	.097	.105	48.4	53.6	.214	1.22	.116	.125	49.8	.190	3.71	-----
16	50.8	54.8	.198	.51	.058	.103	50.5	54.7	.206	.51	.097	.107	49.5	54.8	.238	.51	.105	.124	51.3	55.4	.256	.79	.122	.136	53.9	.187	3.17	-----
17	51.5	54.9	.218	.52	.066	.109	50.8	54.9	.221	.52	.104	.111	49.3	54.9	.249	.52	.114	.125	49.4	55.9	.266	.90	.134	.145	54.1	.182	4.29	-----
18	57.0	54.8	.220	1.08	.077	.125	55.9	55.4	.240	1.08	.112	.136	54.1	55.1	.254	1.08	.139	.144	57.5	57.0	.304	1.87	.171	.201	61.2	.170	4.62	-----

See footnotes at end of table.

TABLE 14.—*Evaporation from a circular reservoir and from standard tanks at Fort Collins, Colo. (elevation 5,000 feet, barometric pressure 24.990 inches), as observed and as computed from formula 10, and pertinent meteorological data*—Continued

Date	Reservoir						Geological Survey floating tank						Colorado type land tank, class A						Weather Bureau land tank, class A						Other meteorological data			
	Meteorological data (mean values for 24 hours)				Evaporation in 24 hours		Meteorological data (mean values for 24 hours)				Evaporation in 24 hours		Meteorological data (mean values for 24 hours)				Evaporation in 24 hours		Meteorological data (mean values for 24 hours)				Evaporation in 24 hours		Daily mean air temperature [2]	Daily mean air vapor pressure [2]	Daily mean wind tower velocity [2]	Precipitation
	Temperature		Difference in vapor pressure, e_s-e_d	Velocity of wind at ground	Observed	Computed	Temperature		Difference in vapor pressure, e_s-e_d	Velocity of wind at ground	Observed	Computed	Temperature		Difference in vapor pressure, e_s-e_d	Velocity of wind at ground	Observed	Computed	Temperature		Difference in vapor pressure, e_s-e_d	Velocity of wind at ground [1]	Observed	Computed				
	Air	Water					Air	Water					Air	Water					Air	Water								
1927	°F.	°F.	Inch of mercury	Miles per hour	Inch	Inch	°F.	°F.	Inch of mercury	Miles per hour	Inch	Inch	°F.	°F.	Inch of mercury	Miles per hour	Inch	Inch	°F.	°F.	Inch of mercury	Miles per hour	Inch	Inch	°F.	Inch of mercury	Miles per hour	Inch
Oct. 19	53.0	55.7	0.220	0.75	0.073	0.116	52.2	55.5	0.220	0.75	0.111	0.116	51.1	55.4	0.248	0.75	0.121	0.131	53.6	56.0	0.261	1.27	0.157	0.154	55.3	0.174	4.54	-----
20	53.4	56.3	.239	.51	.071	.120	52.6	56.4	.243	.51	.108	.121	51.6	55.6	.267	.51	.117	.133	54.4	56.3	.284	.87	.137	.154	57.2	.126	3.33	-----
21	51.8	56.1	.245	.81	.079	.131	51.2	55.5	.240	.81	.125	.129	49.1	54.6	.255	.81	.121	.137	51.6	54.8	.265	1.23	.158	.155	53.6	.157	5.33	-----
22	56.1	54.9	.250	1.76	.121	.162	54.7	54.8	.255	1.76	.156	.165	54.4	53.3	.240	1.76	.154	.156	56.0	55.0	.266	2.76	.217	.204	57.3	.220	5.96	-----
23	49.4	55.6	.255	.64	.087	.132	49.6	55.2	.254	.64	.141	.131	48.7	53.1	.260	.64	.122	.134	49.4	52.7	.264	1.03	.133	.148	51.8	.140	2.92	-----
24	50.0	55.0	.250	.59	.078	.128	50.0	54.5	.253	.59	.120	.129	47.6	51.6	.228	.59	.096	.116	49.3	50.7	.224	.96	.116	.124	51.0	.131	3.42	-----
25	50.5	54.6	.235	.68	.079	.122	50.0	54.4	.237	.68	.126	.123	48.9	51.8	.223	.68	.112	.116	51.2	51.0	.232	1.16	.124	.134	53.1	.138	3.92	-----
26	52.7	55.4	.206	.56	.069	.104	52.6	55.0	.228	.56	.107	.115	51.8	53.0	.227	.56	.094	.115	53.2	53.6	.247	.96	.118	.137	53.9	.170	4.00	-----
27	57.2	54.3	.170	1.00	.062	.095	54.2	54.3	.177	1.00	.090	.099	53.0	53.0	.186	1.00	.098	.104	54.5	54.6	.208	1.53	.133	.129	56.3	.196	4.83	-----
28	53.7	54.8	.140	.72	.026	.074	52.2	54.6	.141	.72	.049	.074	52.6	53.9	.148	.72	.049	.078	54.1	55.1	.171	1.28	.097	.101	53.7	.264	4.58	0.031
29	47.9	53.3	.130	4.27	.109	.123	48.1	52.3	.118	4.27	.087	.111	46.5	49.6	.106	4.27	.131	.100	47.7	47.2	.083	6.71	.157	.102	47.6	.229	11.62	.304
30	45.6	51.7	.167	1.96	.099	.112	45.5	51.0	.161	1.96	.116	.108	44.8	48.6	.145	1.96	.086	.097	45.4	47.7	.142	2.82	.083	.110	48.4	.176	5.46	-----
31	40.6	50.7	.162	1.48	.075	.100	40.1	49.1	.143	1.48	.080	.088	38.3	45.4	.114	1.48	.061	.070	39.0	42.5	.090	2.19	.056	.063	40.0	.173	5.75	-----
Nov. 1	38.0	49.4	.164	1.87	.086	.108	37.3	48.0	.149	1.87	.100	.099	36.9	44.1	.115	1.87	.074	.076	37.2	40.8	.083	2.52	.063	.061	38.7	.164	7.41	T.
2	45.1	48.7	.181	3.77	.135	.160	44.5	47.9	.178	3.77	.157	.158	43.4	44.5	.154	3.77	.128	.136	44.6	43.3	.147	5.66	.171	.163	42.0	.116	10.61	-----
3	48.7	48.4	.149	3.01	.088	.118	48.3	47.6	.144	3.01	.110	.114	45.2	45.7	.132	3.01	.103	.105	46.7	45.7	.142	4.60	.149	.140	46.8	.157	10.25	-----
4	53.1	48.5	.156	3.39	.083	.131	52.2	47.9	.158	3.39	.149	.133	51.5	47.5	.158	3.39	.127	.133	52.9	49.0	.185	4.60	.192	.182	54.4	.154	12.36	-----
5	36.1	47.3	.146	.91	.081	.080	36.3	45.4	.126	.91	.072	.069	34.4	43.6	.122	.91	.052	.067	34.5	39.9	.088	1.36	.045	.053	43.8	.158	2.12	-----
6	33.0	45.3	.132	.39	.038	.064	32.3	43.2	.108	.39	.053	.052	30.2	36.2	.054	.39	.018	.026	30.6	32.2	.020	.73	.026	.011	30.2	.152	3.00	-----
7	40.9	44.3	.094	1.18	.039	.054	40.7	43.3	.082	1.18	.060	.047	39.1	38.6	.058	1.18	.036	.034	40.2	35.8	.039	1.77	.023	.025	47.6	.154	5.00	-----
8	39.2	44.1	.105	.50	.031	.052	39.1	43.3	.098	.50	.045	.049	36.9	39.9	.071	.50	.030	.035	37.9	38.0	.062	.92	.029	.034	42.8	.152	3.00	-----
9	44.2	45.3	.124	.89	.036	.068	43.6	45.7	.130	.89	.062	.071	42.6	42.7	.121	.89	.049	.066	44.2	43.2	.122	1.45	.055	.074	45.6	.144	3.96	-----
10	48.4	44.6	.148	5.24	.106	.156	52.4	44.5	.154	5.24	.185	.163	51.7	44.3	.162	5.24	.197	.171	53.2	46.7	.200	7.00	.297	.253	55.0	.136	17.28	-----
11	37.3	44.0	.153	3.01	.127	.122	37.0	42.7	.139	3.01	.123	.110	36.4	42.5	.155	3.01	.122	.123	37.3	38.8	.124	4.16	.116	.115	36.0	.102	6.00	-----
12	34.1	43.7	.137	.58	.045	.070	34.0	42.6	.129	.58	.063	.066	32.8	39.0	.114	.58	.050	.058	34.0	34.8	.082	.97	.044	.045	37.3	.113	3.33	-----

13	40.1	43.1	.126	.74	.039	.066	39.2	42.1	.120	.74	.055	.063	38.1	39.5	.109	.74	.041	.057	39.0	35.2	.078	1.21	.040	.045	41.8	.136	3.62	-----
[24] 14	35.2	42.6	.117	.62	.038	.060	34.3	40.8	.107	.62	.050	.055	33.2	38.7	.100	.62	.037	.051	33.8	34.0	.066	.95	.035	.036	32.3	.124	3.67	-----
15	33.7	41.5	.129	1.61	.056	.081	33.0	38.0	.104	1.61	.067	.066	31.6	34.7	.085	1.61	.048	.054	32.6	32.3	.069	2.40	.046	.049	33.3	.101	8.00	-----
16	33.7	40.4	.108	1.38	.049	.065	32.4	36.2	.078	1.38	.046	.047	31.0	33.4	.066	1.38	.035	.040	32.1	31.9	.055	1.95	.045	.037	35.1	.124	4.67	-----
17	38.8	40.2	.061	1.58	.020	.038	38.2	39.0	.056	1.58	.034	.035	37.6	36.9	.048	1.58	.028	.030	38.6	36.8	.051	2.25	.018	.036	40.9	.166	5.16	.018
18	36.4	39.9	.106	2.10	.055	.073	35.8	38.0	.095	2.10	.071	.065	34.2	36.7	.096	2.10	.062	.066	35.7	36.4	.092	3.17	.078	.075	37.8	.112	8.57	-----
19	37.7	40.8	.092	.92	.035	.051	36.8	39.6	.087	.92	.043	.048	35.2	36.0	.074	.92	.039	.041	37.1	38.3	.096	1.44	.048	.059	37.3	.131	3.67	-----
20	39.7	40.5	.081	.82	.023	.044	39.1	39.4	.079	.82	.034	.042	38.6	38.5	.078	.82	.035	.042	39.7	38.6	.081	1.31	.040	.048	44.4	.142	3.88	-----
21	45.7	40.6	.115	4.25	.106	.108	46.5	40.0	.123	4.25	.144	.116	49.8	39.6	.142	4.25	.152	.134	50.2	51.4	.163	5.62	.186	.180	49.6	.111	11.33	-----
22	34.4	39.9	.086	1.69	.034	.055	33.9	36.8	.061	1.69	.041	.039	34.0	36.0	.061	1.69	.036	.039	34.9	36.3	.063	2.22	.064	.044	30.4	.132	3.25	.075
23	29.0	37.2	.076	.54	-.006	.038	28.2	35.6	.060	.54	-.004	.030	27.2	33.3	.046	.54	-.014	.023	28.7	32.5	.041	.81	.008	.022	28.5	.129	3.88	.017
24	32.6	37.7	.091	.82	.022	.049	32.0	35.1	.072	.82	.031	.039	31.7	32.7	.062	.82	.004	.033	33.3	31.8	.049	1.31	.029	.029	37.2	.110	3.04	-----
25	37.9	38.7	.078	.73	.019	.041	37.9	37.4	.078	.73	.036	.041	36.0	32.8	.046	.73	.046	.024	38.6	33.1	.050	1.18	.023	.029	46.7	.117	3.04	-----
26	39.8	40.7	.090	.61	.023	.046	39.4	40.4	.092	.61	.035	.045	38.2	36.4	.064	.61	.027	.033	40.0	37.7	.080	1.03	.033	.045	46.0	.138	3.29	-----
27	35.6	40.1	.085	.91	.023	.046	35.5	37.7	.067	.91	.036	.037	34.3	36.4	.066	.91	.026	.036	35.8	35.9	.066	1.29	.036	.039	38.0	.128	7.92	-----
28	41.6	39.6	.103	2.98	.069	.082	42.1	38.0	.093	2.98	.092	.074	41.1	35.8	.084	2.98	.070	.067	42.5	36.0	.092	4.07	.090	.085	46.5	.107	6.83	-----
[25] 29	35.2	38.8	.058	1.33	-.021	.035	34.9	36.0	.034	1.33	-.052	.020	34.4	35.1	.028	1.33	.060	.017	35.3	36.2	.038	2.08	.041	.026	32.1	.162	2.79	.797
1928																												
Apr. 5	37.6	46.3	.132	1.09	.074	.075	38.2	45.2	.124	1.09	.069	.071	37.2	44.2	.139	1.09	.112	.079	37.1	40.7	.109	1.63	.104	.069	38.6	.114	4.46	-----
6	37.1	46.0	.132	5.34	.107	.141	37.6	44.8	.121	5.34	.104	.130	36.8	42.8	.126	5.34	.116	.135	36.6	38.4	.094	7.43	.144	.124	33.2	.113	14.50	.006
7	27.8	42.2	.150	7.02	.225	.190	30.0	38.1	.117	7.02	.173	.148	28.4	35.4	.102	7.02	.154	.129	27.0	31.7	.079	9.89	[26] .102	.127	27.4	.082	10.21	-----
8	23.0	40.2	.138	2.11	.104	.095	24.8	36.3	.108	2.11	.094	.074	22.0	33.8	.100	2.11	.069	.069	20.6	30.8	.078	2.90	[26] .103	.061	19.8	.071	2.33	-----
9	28.5	41.2	.128	1.28	.063	.076	28.1	37.9	.104	1.28	.093	.061	26.8	36.4	.109	1.28	.105	.064	27.4	34.0	.092	1.83	[26] .102	.060	35.0	.089	3.46	-----
10	40.1	44.0	.128	3.32	.073	.106	40.5	43.0	.120	3.32	.131	.100	41.0	43.6	.160	3.32	.155	.133	40.8	39.0	.123	4.47	.207	.119	48.0	.110	14.61	-----
11	38.4	43.4	.148	6.84	.221	.185	39.8	41.9	.138	6.84	.212	.172	38.8	41.8	.160	6.84	.212	.200	38.5	40.2	.154	9.71	.288	.244	41.0	.138	9.83	-----
12	39.5	44.4	.136	2.54	.080	.101	40.4	43.4	.139	2.54	.118	.103	40.1	44.4	.167	2.54	.133	.124	39.6	41.4	.148	3.46	.166	.125	41.5	.115	10.37	-----
13	35.1	44.6	.149	4.88	.133	.152	34.7	43.2	.136	4.88	.110	.138	33.6	42.6	.133	4.88	.128	.135	33.2	39.6	.116	6.31	.147	.137	31.4	.139	7.70	T.
14	32.2	43.7	.155	1.55	.081	.096	33.1	39.8	.126	1.55	.111	.079	31.5	38.2	.131	1.55	.108	.082	30.6	39.3	.144	2.16	.103	.100	34.7	.086	6.50	-----
15	46.2	45.4	.161	3.54	.118	.138	46.6	44.8	.148	3.54	.160	.127	45.2	44.7	.176	3.54	.162	.151	45.4	43.2	.178	4.80	.215	.179	42.8	.090	9.25	-----
16	45.9	46.8	.162	2.61	.089	.121	47.8	46.7	.162	2.61	.152	.121	45.5	47.2	.196	2.61	.169	.146	45.2	45.2	.202	3.26	.258	.167	50.0	.113	8.29	-----
17	48.4	49.2	.150	3.60	.140	.130	49.7	48.9	.153	3.60	.201	.132	50.2	51.0	.188	3.60	.261	.163	50.4	51.8	.218	4.38	.337	.208	54.6	.158	17.51	-----
18	46.0	49.5	.195	9.21	.313	.298	47.3	48.4	.190	9.21	.313	.290	47.6	49.4	.215	9.21	.319	.329	47.6	47.6	.206	12.76	.478	.401	47.8	.110	22.71	-----
19	42.8	50.2	.164	3.19	.126	.134	44.0	49.3	.158	3.19	.158	.129	45.0	49.2	.164	3.19	.150	.134	44.5	47.2	.158	4.20	.155	.148	45.0	.164	5.54	.053
20	45.2	51.2	.166	2.35	.096	.119	45.8	50.6	.162	2.35	.144	.116	46.4	50.2	.173	2.35	.158	.124	46.4	48.7	.174	3.23	.198	.143	44.1	.166	9.33	-----
21	38.4	49.5	.162	4.52	([27])	-----	39.2	48.2	.154	4.52	.076	.150	36.8	45.0	.129	4.52	([27])	-----	36.8	40.8	.096	6.10	.076	.111	33.4	.148	5.96	[28] .73
22	35.6	48.9	.166	1.11	.083	.095	34.8	47.6	.161	1.11	.108	.092	33.3	43.2	.127	1.11	.094	.072	34.6	42.0	.126	1.55	.087	.079	32.9	.132	4.04	-----
[29] 23	47.8	52.6	.167	1.40	.074	.101	49.3	52.8	.172	1.40	.117	.104	50.8	53.8	.204	1.40	.127	.123	50.2	55.0	.224	1.93	.155	.150	45.8	.166	4.88	-----
24	51.7	55.1	.172	1.29	.082	.102	52.0	55.8	.204	1.29	.121	.121	53.8	56.9	.243	1.29	.143	.144	54.0	58.8	.287	1.84	.184	.188	50.6	.176	5.17	-----
25	45.9	54.2	.178	1.19	.032	.103	46.5	53.5	.176	1.19	.042	.102	45.1	52.7	.183	1.19	.018	.106	45.5	51.0	.172	1.65	.055	.109	37.8	.180	3.96	.167
26	44.4	53.8	.169	1.63	.075	.107	44.1	53.0	.161	1.63	.116	.102	43.5	51.7	.169	1.63	.104	.107	42.8	46.5	.119	2.18	.100	.083	46.5	.200	5.08	.016
27	48.1	55.4	.161	1.73	.075	.104	48.9	55.7	.169	1.73	.124	.109	49.6	55.4	.199	1.73	.118	.128	49.2	56.4	.208	2.27	.152	.147	47.4	.227	5.58	-----
28	56.6	56.5	.171	2.19	.080	.119	56.6	56.5	.172	2.19	.142	.120	56.1	56.3	.210	2.19	.148	.146	56.6	56.8	.228	2.65	.204	.172	56.8	.231	11.50	-----
29	59.7	55.6	.240	6.06	.273	.278	60.0	55.3	.246	6.06	.332	.284	60.4	55.4	.275	6.06	.273	.318	60.6	56.0	.300	7.21	.450	.388	57.7	.153	16.06	-----
30	59.2	57.4	.253	1.79	.118	.165	57.5	57.0	.249	1.79	.200	.162	57.6	58.4	.304	1.79	.194	.198	57.5	58.0	.315	2.01	.252	.213	54.4	.159	4.87	-----
May 1	60.7	58.8	.217	2.63	.139	.163	62.0	58.8	.228	2.63	.211	.171	63.8	61.2	.297	2.63	.292	.223	63.2	62.9	.362	3.36	.375	.303	61.1	.203	8.88	-----
2	51.3	58.6	.180	2.22	.096	.126	52.1	57.8	.168	2.22	.103	.118	50.6	57.2	.188	2.22	.083	.132	50.6	55.0	.184	3.14	.134	.149	44.0	.250	4.83	.572
3	43.1	56.3	.192	1.14	.064	.110	45.2	54.6	.198	1.14	.082	.114	41.2	49.4	.118	1.14	.021	.068	40.0	43.8	.060	1.80	.002	.039	39.9	.208	4.04	.251
4	46.6	56.0	.180	1.26	.087	.106	47.7	55.2	.162	1.26	.125	.096	47.3	51.6	.156	1.26	.113	.092	45.6	47.9	.132	1.83	.121	.087	45.6	.222	4.54	.065
5	53.8	58.3	.202	1.30	.089	.120	54.4	57.9	.204	1.30	.149	.121	55.8	57.7	.223	1.30	.165	.132	53.8	58.4	.260	1.83	.204	.171	52.5	.233	5.42	-----
6	59.6	60.9	.232	1.54	.108	.144	61.1	60.9	.239	1.54	.182	.149	62.4	61.9	.305	1.54	.192	.190	61.2	63.7	.366	2.13	.274	.253	59.0	.220	5.50	-----

See footnotes at end of table.

TABLE 14.—*Evaporation from a circular reservoir and from standard tanks at Fort Collins, Colo. (elevation 5,000 feet, barometic pressure 24.990 inches), as observed and as computed from formula 10, and pertinent meteorological data*—Continued

Date	Reservoir: Meteorological data (mean values for 24 hours): Temperature: Air	Reservoir: Temperature: Water	Reservoir: Difference in vapor pressure, e_s-e_d	Reservoir: Velocity of wind at ground	Reservoir: Evaporation in 24 hours: Observed	Reservoir: Evaporation: Computed	Geological Survey floating tank: Meteorological data (mean values for 24 hours): Temperature: Air	Geological Survey floating tank: Temperature: Water	Geological Survey floating tank: Difference in vapor pressure, e_s-e_d	Geological Survey floating tank: Velocity of wind at ground	Geological Survey floating tank: Evaporation in 24 hours: Observed	Geological Survey floating tank: Evaporation: Computed	Colorado type land tank, class A: Meteorological data (mean values for 24 hours): Temperature: Air	Colorado type land tank: Temperature: Water	Colorado type land tank: Difference in vapor pressure, e_s-e_d	Colorado type land tank: Velocity of wind at ground	Colorado type land tank: Evaporation in 24 hours: Observed	Colorado type land tank: Evaporation: Computed	Weather Bureau land tank, class A: Meteorological data (mean values for 24 hours): Temperature: Air	Weather Bureau land tank: Temperature: Water	Weather Bureau land tank: Difference in vapor pressure, e_s-e_d	Weather Bureau land tank: Velocity of wind at ground [1]	Weather Bureau land tank: Evaporation in 24 hours: Observed	Weather Bureau land tank: Evaporation: Computed	Other meteorological data: Daily mean air temperature [2]	Other meteorological data: Daily mean air vapor pressure [2]	Other meteorological data: Daily mean wind tower velocity [2]	Other meteorological data: Precipitation
1928	°F.	°F.	Inch of mercury	Miles per hour	Inch	Inch	°F.	°F.	Inch of mercury	Miles per hour	Inch	Inch	°F.	°F.	Inch of mercury	Miles per hour	Inch	Inch	°F.	°F.	Inch of mercury	Miles per hour	Inch	Inch	°F.	Inch of mercury	Miles per hour	Inch
May 7	62.1	62.2	0.208	2.17	0.124	0.145	62.2	62.3	0.228	2.17	0.187	0.159	61.9	63.1	0.290	2.17	0.209	0.202	62.0	64.3	0.330	2.59	0.289	0.246	63.5	0.273	8.32	-----
8	64.8	63.0	.235	1.60	.135	.148	65.8	63.1	.267	1.60	.176	.168	67.4	63.8	.300	1.60	.200	.188	67.0	64.7	.350	2.11	.257	.242	66.0	.258	5.17	-----
9	63.8	63.5	.225	1.51	.125	.139	64.4	63.4	.250	1.51	.155	.155	65.2	63.2	.275	1.51	.199	.170	65.0	62.7	.286	2.01	.208	.194	59.9	.257	8.00	-----
10	52.1	61.7	.217	2.12	.080	.150	52.1	60.8	.200	2.12	.078	.138	51.4	58.0	.176	2.12	−.002	.121	50.2	54.1	.129	3.01	.061	.103	44.9	.291	3.79	0.794
11	48.5	59.6	.195	2.00	.105	.132	47.9	58.5	.183	2.00	.136	.124	45.7	53.4	.138	2.00	.084	.093	45.6	49.6	.101	2.40	.074	.073	48.1	.247	9.25	.005
12	49.9	58.6	.186	2.03	.105	.126	49.9	58.0	.190	2.03	.149	.129	49.7	54.0	.148	2.03	.102	.100	49.4	51.5	.122	2.49	.092	.090	48.1	.242	5.59	T.
13	50.3	58.7	.182	1.54	.097	.113	50.6	58.4	.188	1.54	.113	.117	50.0	55.0	.147	1.54	.089	.091	49.5	53.9	.145	2.25	.102	.102	46.1	.255	7.71	-----
14	48.5	57.5	.154	4.13	.074	.143	48.9	57.1	.159	4.13	.092	.147	47.0	52.5	.112	4.13	.087	.104	46.4	50.5	.096	6.11	.125	.112	45.6	.255	11.74	.660
15	52.5	56.6	.109	3.13	.069	.088	52.4	56.6	.094	3.13	.077	.076	50.5	53.3	.099	3.13	.077	.080	50.6	52.4	.096	4.59	.089	.093	51.7	.275	4.00	.332
16	54.9	58.4	.133	1.03	.042	.075	55.5	58.4	.133	1.03	.073	.075	54.7	57.2	.144	1.03	.079	.081	54.8	58.7	.169	1.60	.125	.106	51.8	.302	5.00	.038
17	54.4	59.4	.193	1.84	.108	.127	55.9	59.4	.205	1.84	.144	.135	57.3	59.3	.224	1.84	.170	.147	55.4	59.1	.216	2.50	.208	.159	52.3	.265	8.30	.002
18	57.1	60.0	.172	3.15	.115	.140	57.1	60.4	.184	3.15	.156	.149	58.5	60.6	.210	3.15	.171	.171	57.3	60.8	.230	4.54	.212	.225	56.3	.299	6.75	.041
19	56.5	60.7	.178	1.19	.057	.103	57.1	60.7	.180	1.19	.094	.104	57.2	60.2	.198	1.19	.104	.115	56.1	59.4	.199	1.59	.132	.125	52.3	.310	5.54	.098
20	58.5	61.7	.199	1.86	.104	.131	59.0	62.4	.203	1.86	.144	.134	58.8	61.6	.250	1.86	.161	.165	58.2	61.3	.252	2.40	.194	.182	57.2	.297	5.91	.017
21	56.1	63.3	.254	.97	.104	.141	56.9	63.0	.264	.97	.160	.146	57.2	63.6	.297	.97	.164	.165	56.2	62.4	.272	1.21	.184	.159	52.8	.277	4.54	-----
22	62.0	65.7	.259	.92	.112	.142	63.1	66.0	.275	.92	.172	.151	63.8	66.9	.320	.92	.186	.176	62.8	67.2	.348	1.19	.226	.202	57.6	.308	5.63	-----
23	66.1	67.6	.291	1.24	.119	.170	67.7	67.8	.303	1.24	.176	.177	66.7	68.6	.360	1.24	.206	.211	65.4	68.7	.384	1.92	.248	.256	62.2	.316	6.46	-----
24	64.8	66.9	.239	2.94	.175	.188	65.7	67.0	.271	2.94	.195	.213	65.8	66.1	.272	2.94	.246	.214	64.3	65.8	.268	4.48	.319	.260	61.6	.334	7.41	.298
25	62.7	67.7	.236	.89	.097	.129	63.8	67.3	.233	.89	.157	.127	64.1	66.7	.265	.89	.168	.144	62.8	65.2	.267	1.53	.165	.166	62.0	.384	3.58	.006
26	67.4	69.4	.287	1.26	.123	.169	68.0	69.6	.296	1.26	.179	.174	68.2	69.8	.361	1.26	.202	.212	68.0	70.9	.409	1.73	.259	.263	65.4	.374	5.50	-----
27	61.7	68.5	.259	1.11	.095	.148	62.8	68.6	.264	1.11	.140	.151	63.5	68.0	.279	1.11	.162	.159	62.0	67.6	.269	1.63	.178	.170	64.3	.331	5.17	.183
28	65.3	69.4	.246	1.13	.094	.140	66.3	69.3	.224	1.13	.146	.129	65.9	69.0	.257	1.13	.140	.148	65.3	68.2	.269	1.57	.161	.168	61.9	.422	4.71	.039
29	66.8	71.3	.290	.66	.104	.150	68.3	71.3	.273	.66	.167	.142	68.3	71.8	.338	.66	.171	.175	67.0	72.1	.369	1.06	.183	.208	62.8	.394	4.29	-----
30	70.9	72.4	.316	1.07	.146	.179	71.8	72.7	.341	1.07	.214	.193	71.6	73.2	.399	1.07	.232	.226	70.9	73.5	.420	1.46	.295	.257	69.4	.389	6.29	-----
31	65.6	72.2	.306	.90	.139	.167	65.2	72.2	.323	.90	.191	.176	65.7	71.2	.348	.90	.180	.190	65.4	70.4	.342	1.31	.198	.203	61.1	.370	4.79	-----

June	1	57.7	70.6	.348	1.00	.144	.194	58.0	69.8	.342	1.00	.160	.191	56.6	66.0	.302	1.00	.119	.168	55.9	62.7	.234	1.54	.109	.146	52.0	.304	3.12	.048
	2	58.5	69.5	.321	1.13	.134	.184	59.3	68.9	.311	1.13	.160	.178	59.3	64.3	.248	1.13	.185	.142	58.6	61.6	.205	1.53	.176	.127	56.1	.347	6.96	.428
	3	56.0	67.0	[31] .297	1.55	.156	.185	55.7	65.6	[31] .267	1.55	.147	.166	[31] 51.1	[31] 60.4	[31] .179	1.55	(32)	-----	48.8	54.9	.097	2.34	.081	.069	46.6	.337	4.25	1.262
	4	56.8	64.8	.235	1.06	.119	.133	57.3	64.4	.238	1.06	.163	.134	[31] 56.6	[31] 59.8	[31] .148	1.06	.082	.084	52.8	55.4	.110	1.33	.068	.066	51.4	.292	6.04	.075
	5	58.7	66.1	.218	.87	.104	.118	58.8	66.0	.238	.87	.144	.129	58.8	63.2	.230	.87	.128	.125	58.9	63.2	.237	1.33	.150	.141	53.5	.320	3.33	.134
	6	62.9	68.2	.252	.77	.102	.134	63.6	68.2	.289	.77	.168	.154	63.8	68.1	.310	.77	.147	.165	64.8	69.4	.384	1.06	.207	.217	59.0	.364	5.17	-----
	7	67.9	69.9	.286	1.22	.131	.167	68.4	69.7	.297	1.22	.197	.174	68.4	70.3	.352	1.22	.197	.206	67.5	71.5	.402	1.62	.268	.254	63.7	.342	6.80	.018
	8	62.6	68.8	.333	1.46	.171	.204	63.6	68.6	.334	1.46	.222	.204	63.4	67.8	.365	1.46	.225	.224	62.3	66.0	.343	2.04	.243	.233	58.7	.280	5.25	.012
	9	53.2	66.9	.310	.55	.132	.156	53.6	65.5	.286	.55	.140	.144	52.1	62.1	.252	.55	.099	.127	51.2	56.8	.164	.90	.073	.090	49.0	.267	5.42	.076
	10	51.8	64.8	.252	.97	.128	.140	52.2	63.3	.227	.97	.146	.126	50.7	57.3	.146	.97	.068	.081	49.5	52.8	.078	1.33	.035	.031	49.0	.314	4.58	.018
	11	59.1	64.5	.184	1.27	.106	.108	59.4	64.0	.184	1.27	.128	.108	58.5	60.2	.140	1.27	.094	.083	57.7	59.6	.137	2.12	.130	.095	58.4	.314	7.21	.007
	12	57.8	63.3	.296	2.70	.217	.225	58.2	62.8	.297	2.70	.242	.226	58.0	59.5	.258	2.70	.210	.196	57.6	58.0	.230	4.37	.240	.220	50.4	.201	7.75	-----
	13	58.3	63.5	.264	.89	.143	.144	59.1	63.1	.263	.89	.171	.143	59.8	62.2	.299	.89	.172	.163	58.7	60.2	.290	1.11	.157	.166	51.2	.247	5.08	-----
	14	58.7	64.8	.224	.76	.069	.119	60.6	64.8	.238	.76	.139	.126	58.9	63.9	.244	.76	.125	.129	58.3	64.4	.278	1.23	.156	.163	56.2	.295	3.33	.016
	15	62.4	66.4	.234	.53	.087	.118	64.5	66.4	.233	.53	.123	.117	63.3	66.4	.291	.53	.128	.146	62.2	66.7	.302	.85	.153	.163	58.3	.338	4.54	-----
	16	65.6	67.4	.214	1.65	.089	.136	67.3	68.0	.233	1.65	.164	.148	64.9	68.6	.285	1.65	.178	.181	65.0	69.9	.317	2.40	.220	.229	63.4	.416	6.83	-----
	17	57.8	67.6	.261	1.96	.141	.175	58.4	67.3	.266	1.96	.214	.179	57.4	67.0	.298	1.96	.183	.200	57.1	64.3	.251	2.90	.223	.196	56.0	.312	8.00	.174
	18	54.3	66.0	.284	1.63	.166	.179	54.8	65.2	.281	1.63	.187	.177	54.3	61.8	.246	1.63	.151	.155	53.4	58.2	.188	2.25	.143	.133	52.2	.281	4.00	.231
	19	59.6	66.6	.316	.68	.120	.164	61.8	66.1	.317	.68	.176	.165	60.4	64.1	.312	.68	.144	.162	59.4	62.5	.301	1.09	.159	.171	53.0	.254	4.00	-----
	20	62.1	67.0	.287	.87	.128	.156	63.2	66.8	.290	.87	.173	.158	63.2	65.7	.317	.87	.160	.172	62.3	64.9	.314	1.17	.190	.181	55.6	.278	4.33	-----
	21	65.1	68.5	.263	1.31	.115	.157	67.4	68.3	.274	1.31	.176	.163	66.4	68.9	.334	1.31	.205	.199	65.9	68.0	.316	1.93	.152	.211	63.5	.312	6.37	-----
	22	65.6	68.1	.288	2.14	.178	.199	67.0	68.2	.298	2.14	.253	.206	67.6	69.0	.336	2.14	.248	.232	66.3	67.8	.321	2.80	.297	.247	61.6	.322	8.67	-----
	23	63.9	67.9	.305	.88	.132	.166	64.2	67.1	.300	.88	.151	.163	65.6	66.8	.319	.88	.141	.174	64.5	64.4	.286	1.27	.149	.169	56.0	.270	4.71	.004
	24	62.0	68.1	.316	.92	.140	.173	62.9	67.6	.335	.92	.206	.184	63.3	66.6	.347	.92	.175	.190	62.8	65.6	.333	1.18	.195	.193	56.0	.278	4.41	-----
	25	63.9	69.6	.290	.73	.105	.152	65.6	69.4	.321	.73	.153	.169	65.4	69.5	.341	.73	.169	.179	64.4	68.7	.321	1.00	.198	.179	59.5	.348	4.67	.087
	26	62.0	69.3	.210	.84	.085	.113	62.5	69.0	.210	.84	.119	.113	62.8	68.2	.210	.84	.111	.113	62.1	66.6	.187	1.12	.113	.107	59.8	.452	5.80	.141
	27	68.4	71.1	.195	1.57	.092	.122	69.9	71.0	.202	1.57	.141	.126	68.4	71.0	.246	1.57	.146	.154	67.9	70.6	.245	2.33	.170	.175	68.2	.474	4.83	.007
	28	71.3	73.8	.288	.76	.090	.153	72.1	73.5	.290	.76	.154	.154	70.8	75.0	.342	.76	.172	.181	71.6	76.4	.420	1.10	.125	.240	69.4	.474	5.62	.001
	29	68.0	73.5	.255	1.07	.105	.144	68.0	73.0	.254	1.07	.142	.144	67.2	72.6	.243	1.07	.155	.137	67.0	71.8	.272	1.39	.173	.164	65.0	.474	4.41	.194
	30	69.0	73.7	.331	.95	.132	.183	70.3	73.4	.325	.95	.202	.179	69.7	73.2	.361	.95	.184	.199	68.8	72.2	.361	1.17	.209	.209	65.8	.400	7.25	-----
July	1	73.8	75.6	.398	1.14	.154	.229	74.5	75.4	.402	1.14	.246	.231	75.7	76.6	.484	1.14	.246	.278	74.9	77.5	.529	1.60	.316	.332	71.9	.457	7.41	-----
	2	71.1	75.0	.393	2.23	.272	.276	71.4	74.8	.431	2.23	.346	.303	73.3	75.4	.479	2.23	.330	.337	72.5	75.0	.509	2.78	.372	.391	67.2	.392	7.08	-----
	3	72.2	75.6	.397	.86	.172	.215	72.5	75.1	.432	.86	.223	.234	73.6	75.6	.509	.86	.231	.275	73.4	74.8	.522	1.11	.260	.298	67.6	.342	5.33	-----
	4	72.6	76.1	.461	.74	.184	.243	73.1	75.2	.432	.74	.262	.227	75.0	76.1	.575	.74	.257	.303	73.8	74.0	.521	1.13	.274	.298	68.6	.325	4.91	-----
	5	77.0	77.4	.464	1.02	.190	.260	77.2	76.4	.462	1.02	.294	.259	79.8	78.0	.585	1.02	.304	.328	79.0	78.2	.626	1.34	.351	.374	71.2	.360	6.42	-----
	6	77.2	77.6	.440	.91	.204	.240	77.4	77.0	.452	.91	.268	.247	79.0	78.0	.560	.91	.259	.306	79.2	77.4	.572	1.12	.308	.327	67.6	.368	7.96	-----
	7	70.6	75.7	.438	2.49	.316	.321	71.7	75.5	.446	2.49	.351	.328	72.1	74.9	.492	2.49	.361	.362	71.2	73.2	.480	3.44	.348	.406	63.8	.386	5.84	-----
	8	69.3	75.3	.466	1.01	.227	.260	69.8	74.6	.472	1.01	.297	.264	71.0	74.8	.539	1.01	.271	.301	69.9	72.9	.539	1.25	.274	.316	61.0	.360	4.67	-----
	9	73.6	76.3	.454	.67	.185	.236	74.2	75.8	.460	.67	.271	.239	74.4	76.2	.549	.67	.256	.285	73.9	75.2	.527	.84	.290	.284	67.6	.340	5.21	-----
	10	75.2	77.0	.418	.82	.191	.224	75.7	76.6	.424	.82	.255	.228	76.8	76.9	.495	.82	.266	.266	76.6	77.1	.513	1.24	.316	.300	71.1	.383	3.88	-----
	11	70.1	75.9	.355	.54	.145	.179	70.4	75.6	.360	.54	.184	.182	72.4	74.9	.384	.54	.170	.194	71.1	74.2	.338	.80	.159	.180	65.2	.442	3.29	.007
	12	70.0	76.2	.384	.78	.156	.204	70.7	75.7	.370	.78	.228	.197	71.5	74.9	.394	.78	.216	.209	70.6	73.0	.395	1.07	.218	.223	65.7	.442	4.46	-----
	13	70.8	76.2	.345	1.00	.144	.192	71.3	75.6	.328	1.00	.184	.183	71.1	74.7	.365	1.00	.189	.204	69.9	73.5	.345	1.61	.192	.218	69.2	.477	5.08	-----
	14	69.8	75.6	.336	1.12	.146	.192	71.0	75.0	.314	1.12	.188	.180	71.6	74.0	.335	1.12	.171	.191	70.2	71.9	.300	1.61	.170	.189	68.0	.481	4.92	.075
	15	74.1	76.0	.370	1.14	.172	.212	74.5	75.6	.372	1.14	.245	.213	75.4	74.8	.430	1.14	.246	.247	74.8	73.9	.414	1.62	.295	.261	68.8	.424	5.00	-----
	16	74.7	76.8	.358	1.14	.148	.206	75.4	76.2	.362	1.14	.199	.208	78.3	76.8	.438	1.14	.231	.251	76.5	75.8	.433	1.66	.260	.276	72.4	.478	5.88	.006
	17	70.2	76.0	.290	1.12	.117	.166	70.6	75.4	.280	1.12	.150	.160	69.9	74.4	.307	1.12	.147	.176	69.1	72.4	.248	1.67	.137	.158	67.4	.531	3.92	.015
	18	69.6	75.6	.282	.66	.099	.146	70.0	75.1	.270	.66	.131	.140	68.2	73.2	.248	.66	.109	.129	67.9	72.0	.239	.98	.112	.133	66.6	.500	5.04	.059
	19	71.0	75.7	.317	1.54	.130	.197	71.0	75.4	.323	1.54	.218	.201	72.1	74.2	.342	1.54	.194	.213	71.4	73.6	.329	2.03	.235	.224	70.2	.474	6.38	.002
	20	70.8	75.8	.340	1.27	.153	.200	71.4	75.4	.328	1.27	.189	.194	72.2	74.0	.342	1.27	.182	.202	71.2	72.4	.298	1.89	.195	.198	68.5	.453	6.33	.020
	21	70.1	75.6	.332	1.33	.157	.198	70.4	75.2	.350	1.33	.186	.209	69.4	73.2	.344	1.33	.178	.205	69.2	72.5	.329	2.03	.188	.224	67.6	.472	4.17	.039

See footnotes at end of table.

TABLE 14.—*Evaporation from a circular reservoir and from standard tanks at Fort Collins, Colo. (elevation 5,000 feet, barometric pressure 24.990 inches), as observed and as computed from formula 10, and pertinent meteorological data*—Continued

Date	Reservoir						Geological Survey floating tank						Colorado type land tank class A						Weather Bureau land tank, class A						Other meteorological data			
	Meteorological data (mean values for 24 hours)				Evaporation in 24 hours		Meteorological data (mean values for 24 hours)				Evaporation in 24 hours		Meteorological data (mean values for 24 hours)				Evaporation in 24 hours		Meteorological data (mean values for 24 hours)				Evaporation in 24 hours					
	Temperature		Difference in vapor pressure, $e_s - e_d$	Velocity of wind at ground			Temperature		Difference in vapor pressure, $e_s - e_d$	Velocity of wind at ground			Temperature		Difference in vapor pressure, $e_s - e_d$	Velocity of wind at ground			Temperature		Difference in vapor pressure, $e_s - e_d$	Velocity of wind at ground[1]						
	Air	Water			Observed	Computed	Air	Water			Observed	Computed	Air	Water			Observed	Computed	Air	Water			Observed	Computed	Daily mean air temperature[3]	Daily mean air vapor pressure[2]	Daily mean wind tower velocity[2]	Precipitation
1928	°F.	°F.	Inch of mercury	Miles per hour	Inch	Inch	°F.	°F.	Inch of mercury	Miles per hour	Inch	Inch	°F.	°F.	Inch of mercury	Miles per hour	Inch	Inch	°F.	°F.	Inch of mercury	Miles per hour	Inch	Inch	°F.	Inch of mercury	Miles per hour	Inch
July 22	67.9	75.5	0.329	1.10	0.157	0.187	68.4	74.7	0.322	1.10	0.193	0.183	68.4	73.2	0.343	1.10	0.195	0.195	67.5	71.7	0.309	1.69	0.195	0.198	65.4	0.437	4.84	-----
23	67.5	74.2	.320	.72	.139	.168	68.3	73.2	.324	.72	.152	.170	67.0	70.1	.283	.72	.142	.149	66.3	66.4	.206	1.14	.118	.118	66.2	.432	4.84	0.027
24	67.2	73.0	.298	1.36	.132	.179	67.3	72.5	.306	1.36	.143	.184	66.6	68.8	.268	1.36	.123	.161	66.3	67.0	.240	2.07	.135	.164	63.4	.417	3.58	.286
25	67.3	73.9	.340	.72	.113	.179	69.4	73.6	.346	.72	.165	.182	68.1	71.9	.372	.72	.166	.195	67.5	71.0	.326	1.14	.180	.188	67.4	.431	3.25	.004
26	72.6	75.8	.391	.67	.134	.203	74.9	75.4	.392	.67	.191	.204	74.2	75.1	.454	.67	.222	.236	73.8	75.1	.458	1.08	.259	.260	69.4	.420	4.13	-----
27	69.4	76.1	.389	1.11	.168	.222	70.8	75.5	.378	1.11	.217	.216	71.5	75.2	.428	1.11	.281	.244	70.9	73.8	.383	1.62	.360	.242	68.6	.448	5.08	.370
28	68.4	76.3	.307	.96	.123	.170	69.4	76.0	.302	.96	.153	.167	68.2	75.1	.341	.96	.160	.189	67.3	73.2	.293	1.45	.160	.179	68.0	.516	4.83	-----
29	67.6	75.5	.311	1.03	.131	.175	67.6	75.0	.294	1.03	.180	.165	68.6	73.4	.298	1.03	.150	.167	67.8	70.4	.238	1.64	.154	.151	64.6	.521	4.63	.140
[33] 30	72.7	76.8	.335	1.03	.121	.188	73.0	76.4	.334	1.03	.186	.188	74.0	75.3	.353	1.03	.189	.198	73.4	74.9	.378	1.44	.214	.230	72.3	.498	4.21	.004
Aug. 1	73.1	73.8	.293	.88	.143	.159	73.3	73.2	.289	.88	.169	.157	74.1	72.4	.328	.88	.185	.178	73.4	71.1	.293	1.32	.204	.175	72.8	.454	5.25	-----
2	67.3	73.5	.329	1.50	.164	.203	66.7	72.4	.339	1.50	.210	.209	66.6	71.6	.352	1.50	.212	.217	66.3	69.4	.297	2.10	.213	.205	64.0	.395	6.12	.290
3	62.9	72.1	.295	1.15	.157	.170	63.0	70.8	.271	1.15	.189	.156	62.5	68.4	.261	1.15	.145	.150	62.0	64.8	.197	1.57	.138	.123	62.6	.398	5.12	-----
4	64.1	72.0	.314	.82	.138	.169	64.3	70.4	.304	.82	.178	.163	64.8	68.8	.321	.82	.160	.172	64.1	66.6	.276	1.31	.157	.164	60.0	.379	3.67	.006
5	65.8	71.0	.330	1.72	.197	.212	67.9	69.7	.305	1.72	.229	.196	66.3	67.4	.308	1.72	.201	.198	65.6	65.8	.268	2.20	.231	.188	61.6	.352	7.58	-----
6	66.8	69.8	.328	1.09	.141	.187	67.4	68.4	.296	1.09	.174	.168	67.6	66.6	.292	1.09	.188	.166	66.3	64.7	.268	1.61	.200	.169	61.4	.294	5.54	.073
7	66.3	70.6	.352	.84	.135	.190	67.0	70.1	.342	.84	.186	.184	68.1	68.0	.362	.84	.181	.195	67.2	66.8	.351	1.31	.208	.209	65.0	.336	3.14	-----
8	67.6	72.6	.364	.48	.133	.181	68.0	72.0	.372	.48	.202	.185	70.1	72.2	.436	.48	.206	.217	69.5	72.8	.459	.91	.263	.251	67.9	.371	3.96	-----
9	71.6	74.2	.389	.78	.145	.207	71.5	73.4	.390	.78	.206	.207	73.5	74.9	.497	.78	.260	.264	72.8	75.4	.518	1.10	.306	.295	69.0	.353	3.88	-----
10	72.3	74.8	.393	1.00	.177	.219	72.6	73.8	.412	1.00	.272	.230	74.7	75.2	.514	1.00	.304	.286	74.3	74.3	.492	1.38	.350	.296	69.6	.376	5.96	-----
11	73.2	74.6	.412	.97	.182	.228	74.4	73.4	.396	.97	.242	.219	76.2	74.4	.496	.97	.268	.275	74.3	71.5	.434	1.55	.300	.270	70.5	.334	4.08	-----
12	75.1	74.7	.425	.92	.172	.233	81.7	74.4	.411	.92	.254	.225	78.3	74.7	.516	.92	.280	.283	76.7	74.1	.525	1.29	.307	.310	72.3	.350	4.17	-----
13	73.1	74.3	.385	.97	.200	.213	80.8	75.0	.407	.97	[34] .254	.226	75.7	75.0	.460	.97	.260	.255	74.6	73.4	.458	1.24	.291	.268	73.6	.398	5.42	-----
14	71.9	75.1	.389	.80	.152	.208	72.2	74.3	.374	.80	.219	.199	74.3	73.7	.426	.80	.238	.228	73.3	72.2	.404	1.17	.260	.233	68.0	.425	5.04	.001
15	73.0	75.7	.346	.90	.145	.189	80.7	75.0	.362	.90	.177	.198	75.3	74.3	.405	.90	.214	.221	74.2	74.5	.430	1.45	.239	.263	72.0	.463	4.29	T.
16	67.3	73.7	.284	.94	.122	.156	67.0	72.4	.240	.94	.133	.132	66.5	71.9	.304	.94	.146	.167	65.8	68.4	.224	1.64	.115	.137	65.6	.483	3.17	.170

17	68.8	73.6	.297	1.14	.148	.171	69.8	72.7	.294	1.14	.207	.169	70.6	72.5	.320	1.14	.194	.184	68.9	[35]69.0	[35].285	1.60	.230	.179	68.4	.433	5.67	-----
18	73.3	74.0	.418	.86	.183	.226	73.5	73.9	.424	.86	.265	.229	73.1	73.2	.474	.86	.256	.256	72.3	70.5	.444	1.28	.282	.263	69.4	.333	3.96	-----
19	72.7	73.4	.387	1.00	.196	.216	72.8	74.4	.435	1.00	[34].260	.242	74.1	73.0	.453	1.00	.270	.253	73.0	71.0	.416	1.45	.217	.254	72.4	.304	6.50	-----
20	73.7	74.5	.446	1.27	.205	.263	74.6	74.0	.473	1.27	.259	.279	74.4	72.5	.503	1.27	.283	.297	74.0	71.1	.484	1.73	.306	.311	67.8	.257	5.21	-----
21	68.7	74.8	.387	.74	.152	.204	70.4	74.4	.395	.74	.200	.208	69.3	73.8	.418	.74	.220	.220	68.6	71.5	.384	1.21	.222	.224	69.4	.352	3.38	-----
22	71.8	74.1	.433	1.83	.238	.287	72.2	74.2	.432	1.83	.316	.284	71.6	72.0	.418	1.83	.310	.274	70.7	71.0	.435	2.61	.363	.326	71.2	.319	13.62	T.
23	62.1	68.8	.380	4.00	.378	.346	62.7	69.4	.399	4.00	[34].322	.364	63.0	64.9	.319	4.00	.341	.290	61.4	62.2	.278	5.56	.283	.305	58.3	.266	3.71	.002
24	60.7	70.2	.345	.66	.132	.179	61.7	69.1	.340	.66	.162	.176	66.5	67.2	.365	.66	.171	.189	60.5	65.3	.310	1.09	.166	.176	59.9	.298	3.71	-----
25	62.0	69.4	.330	1.02	.156	.185	61.6	68.4	.329	1.02	.207	.184	61.6	66.0	.334	1.02	.195	.187	61.0	63.0	.287	1.50	.182	.177	58.8	.292	2.08	-----
26	67.3	68.7	.332	1.47	.147	.204	68.0	68.2	.311	1.47	.185	.191	67.8	66.2	.328	1.47	.179	.202	67.0	64.9	.319	2.21	.211	.224	62.8	.288	5.08	-----
27	68.6	69.8	.350	1.68	.162	.223	68.6	69.6	.322	1.68	.248	.205	70.1	69.2	.416	1.68	.232	.265	69.7	69.4	.447	2.26	.292	.316	66.6	.329	6.84	.193
28	65.3	70.2	.372	.75	.139	.197	65.6	69.8	.359	.75	.182	.190	66.0	68.9	.395	.75	.192	.209	65.3	66.9	.355	1.18	.196	.205	63.4	.272	5.75	-----
29	65.9	70.4	.339	1.54	.154	.211	65.7	69.8	.322	1.54	.210	.200	66.2	69.1	.378	1.54	.233	.235	65.5	68.1	.368	2.18	.251	.256	64.8	.304	5.88	-----
30	64.5	70.1	.348	.83	.156	.187	65.0	69.3	.344	.83	.177	.185	64.5	67.3	.364	.83	.191	.196	63.6	65.1	.334	1.33	.190	.199	61.3	.258	4.79	-----
31	63.9	69.1	.332	1.29	.154	.196	64.6	68.0	.331	1.29	.172	.196	64.7	65.6	.308	1.29	.190	.182	63.5	63.4	.277	1.84	.178	.182	61.8	.274	4.17	-----
Sept. 1	60.8	67.9	.304	1.01	.136	.170	61.3	66.8	.284	1.01	.163	.159	60.9	64.2	.276	1.01	.136	.154	60.0	61.2	.216	1.51	.151	.134	60.6	.320	5.33	T.
2	60.4	67.0	.291	1.05	.133	.164	60.8	65.8	.267	1.05	.170	.150	60.9	63.4	.277	1.05	.164	.156	60.4	60 7	.236	1.66	.163	.150	62.0	.265	4.63	-----
3	63.1	66.8	.306	.92	.121	.168	63.8	65.8	.294	.92	.154	.161	63.1	63.6	.296	.92	.164	.162	63.0	62.1	.286	1.39	.172	.173	61.6	.267	5.25	.017
4	62.5	67.4	.297	.92	.118	.163	62.7	66.4	.279	.92	.164	.153	65.4	65.4	.328	.92	.176	.180	63.9	64.1	.313	1.37	.182	.188	63.4	.298	4.50	.006
5	64.2	68.4	.321	.86	.124	.174	64.9	67.6	.316	.86	.161	.171	67.0	67.1	.361	.86	.180	.195	64.6	66.5	.352	1.30	.207	.209	61.8	.288	3.96	-----
6	61.8	68.6	.327	.54	.110	.165	62.6	67.8	.320	.54	.138	.161	64.9	67.3	.379	.54	.162	.191	62.5	65.7	.346	.85	.173	.187	62.1	.285	4.21	-----
7	67.9	68.8	.335	1.05	.133	.189	68.4	68.2	.344	1.05	.170	.194	70.0	67.6	.378	1.05	.189	.214	69.0	67.1	.379	1.46	.209	.232	69.2	.282	5.33	-----
8	67.4	68.3	.334	1.27	.138	.197	68.8	67.6	.324	1.27	.193	.191	72.4	68.1	.403	1.27	.241	.238	70.8	66.9	.377	1.74	.257	.244	66.9	.311	4.96	.035
9	61.7	68.2	.218	.69	.082	.114	62.0	67.4	.214	.69	.108	.111	62.6	67.0	.248	.69	.084	.129	61.5	65.0	.209	.97	.103	.116	63.3	.360	5.08	.001
10	57.5	66.7	.318	1.29	.165	.188	57.8	65.6	.280	1.29	.197	.166	56.4	62.9	.292	1.29	.181	.173	55.1	59.4	.229	1.85	.173	.151	55.4	.223	7.46	T.
11	58.4	65.1	.251	2.62	.188	.188	58.6	64.1	.252	2.62	.220	.189	60.8	61.0	.278	2.62	.210	.208	58.2	58.6	.237	3.74	.244	.209	58.6	.261	6.96	.028
12	57.5	64.8	.333	1.26	.153	.196	57.7	63.9	.331	1.26	.202	.195	60.9	62.0	.345	1.26	.203	.204	58.4	58.9	.304	1.67	.208	.194	59.0	.219	7.42	-----
13	57.4	64.2	.358	3.67	.292	.313	58.7	62.8	.340	3.67	.354	.297	58.7	60.9	.336	3.67	.284	.294	58.1	58.8	.318	4.57	.342	.312	54.3	.171	19.63	-----
14	59.7	63.3	.318	2.39	.178	.230	60.0	61.8	.287	2.39	.237	.207	61.9	61.2	.334	2.39	.222	.241	59.9	58.8	.286	3.46	.232	.242	63.4	.203	4.88	-----
15	59.8	64.1	.302	.62	.097	.155	60.3	63.5	.293	.62	.135	.150	62.6	63.5	.346	.62	.160	.177	61.5	63.6	.357	.93	.186	.196	60.8	.249	6.46	-----
16	59.1	64.3	.272	2.28	.161	.193	59.1	63.6	.276	2.28	.200	.196	60.2	63.7	.319	2.28	.218	.226	59.0	63.2	.316	3.08	.258	.254	56.4	.256	6.25	-----
17	59.8	65.2	.280	.81	.091	.150	60.5	64.4	.269	.81	.117	.144	61.0	64.9	.335	.81	.153	.180	59.2	63.8	.309	1.37	.170	.186	60.6	.269	3.50	-----
18	61.5	64.7	.262	1.22	.126	.153	61.5	63.7	.256	1.22	.175	.149	63.6	63.2	.304	1.22	.179	.177	62.4	61.6	.274	1.74	.192	.177	64.5	.292	6.21	-----
19	65.0	65.0	.299	1.61	.131	.189	64.8	64.4	.324	1.61	.184	.204	67.5	64.0	.335	1.61	.206	.211	66.2	62.4	.314	2.59	.219	.234	69.0	.249	6.63	-----
20	57.2	63.7	.278	1.50	.128	.172	57.0	62.4	.264	1.50	.181	.163	56.9	61.2	.276	1.50	.148	.170	56.0	58.4	.232	1.99	.163	.157	50.4	.239	4.46	.025
21	52.6	62.7	.300	.79	.122	.160	53.6	61.2	.269	.79	.134	.144	53.8	59.2	.272	.79	.143	.145	51.4	54.9	.216	1.18	.125	.125	48.8	.225	3.92	.001
22	52.9	63.0	.301	.61	.118	.154	53.2	62.0	.278	.61	.149	.142	54.6	59.7	.278	.61	.149	.142	52.3	57.8	.268	1.08	.164	.152	52.8	.214	4.50	-----
23	51.4	62.6	.283	.93	.115	.156	51.8	62.0	.274	.93	.135	.151	52.6	59.1	.249	.93	.130	.137	49.6	57.7	.252	1.29	.146	.149	50.6	.215	4.29	-----
24	53.6	62.6	.273	.98	.121	.152	54.4	58.3	.223	.98	.151	.124	55.6	59.6	.278	.98	.162	.154	53.2	57.9	.259	1.57	.153	.162	52.5	.226	4.58	-----
25	50.8	62.1	.292	1.19	.129	.169	51.2	61.2	.279	1.19	.155	.162	51.0	58.2	.266	1.19	.147	.154	48.7	55.7	.232	1.93	.140	.155	50.0	.201	3.88	-----
26	52.3	61.4	.284	1.19	.140	.165	53.0	60.9	.279	1.19	.168	.162	54.1	57.9	.284	1.19	.158	.165	51.3	55.7	.254	1.52	.155	.157	50.4	.192	6.00	-----
27	47.3	59.8	.296	.62	.129	.152	48.5	58.4	.279	.62	.148	.143	48.4	54.0	.243	.63	.120	.125	46.0	50.4	.196	1.05	.115	.110	45.5	.149	2.92	-----
28	56.8	59.4	.234	1.40	.103	.142	57.8	58.2	.227	1.40	.146	.137	59.6	55.5	.209	1.40	.138	.126	57.9	53.4	.192	2.24	.178	.135	60.6	.219	6.13	-----
29	59.0	61.1	.286	.81	.091	.153	59.6	60.3	.254	.81	.130	.136	60.9	59.4	.297	.81	.141	.159	59.4	59.0	.300	1.18	.170	.174	58.8	.222	4.42	-----
30	59.8	62.3	.272	.70	.090	.142	60.2	61.6	.271	.70	.115	.141	59.4	60.9	.294	.70	.128	.154	59.1	60.9	.310	1.07	.156	.176	62.5	.225	7.25	-----
Oct. 1	58.8	61.2	.260	2.11	.143	.179	58.9	61.0	.261	2.11	.190	.180	60.3	60.8	.317	2.11	.199	.218	59.2	60.2	.300	2.79	.234	.231	56.6	.243	4.67	-----
2	53.4	61.4	.266	.66	.106	.138	54.4	60.4	.252	.66	.146	.130	54.0	59.4	.313	.66	.149	.162	52.4	56.2	.269	1.00	.146	.150	53.7	.201	4.21	-----
3	54.0	61.4	.304	.97	.122	.168	53.6	60.2	.288	.97	.179	.160	53.6	58.5	.309	.97	.167	.171	52.7	56.2	.296	1.41	.175	.179	58.2	.158	6.30	-----
4	56.2	60.5	.272	2.38	.159	.196	55.7	59.9	.264	2.38	.205	.190	56.8	57.4	.256	2.38	.194	.185	56.0	57.3	.266	3.22	.238	.218	56.3	.194	7.17	.007
5	53.2	60.0	.271	.73	.107	.143	53.0	58.9	.277	.73	.131	.146	52.4	55.8	.286	.73	.134	.150	51.9	53.6	.253	1.16	.130	.146	54.4	.170	3.79	-----
6	52.4	59.9	.250	.84	.108	.135	52.4	59.1	.254	.84	.149	.137	52.3	57.4	.282	.84	.144	.152	51.6	55.4	.247	1.20	.156	.144	52.5	.189	4.79	----

See footnotes at end of table.

TABLE 14.—*Evaporation from a circular reservoir and from standard tanks at Fort Collins, Colo. (elevation 5,000 feet, barometric pressure 24.990 inches), as observed and as computed from formula 10, and pertinent meteorological data*—Continued

Date	Reservoir						Geological Survey floating tank						Colorado type land tank, class A						Weather Bureau land tank, class A						Other meteorological data			
	Meteorological data (mean values for 24 hours)				Evaporation in 24 hours		Meteorological data (mean values for 24 hours)				Evaporation in 24 hours		Meteorological data (mean values for 24 hours)				Evaporation in 24 hours		Meteorological data (mean values for 24 hours)				Evaporation in 24 hours					
	Temperature		Difference in vapor pressure, e_s-e_d	Velocity of wind at ground			Temperature		Difference in vapor pressure, e_s-e_d	Velocity of wind at ground			Temperature		Difference in vapor pressure, e_s-e_d	Velocity of wind at ground			Temperature		Difference in vapor pressure, e_s-e_d	Velocity of wind at ground [1]						
	Air	Water			Observed	Computed	Air	Water			Observed	Computed	Air	Water			Observed	Computed	Air	Water			Observed	Computed	Daily mean air temperature [2]	Daily mean air vapor pressure [2]	Daily mean wind tower velocity [2]	Precipitation
1928	°F.	°F.	Inch of mercury	Miles per hour	Inch	Inch	°F.	°F.	Inch of mercury	Miles per hour	Inch	Inch	°F.	°F.	Inch of mercury	Miles per hour	Inch	Inch	°F.	°F.	Inch of mercury	Miles per hour	Inch	Inch	°F.	Inch of mercury	Miles per hour	Inch
Oct. 7	53.9	60.0	0.267	0.72	0.093	0.140	54.2	59.3	0.251	0.72	0.137	0.132	53.6	57.4	0.272	0.72	0.126	0.143	53.2	55.2	0.250	1.17	0.126	0.144	57.2	0.199	5.21	-----
8	57.1	60.1	.266	1.15	.109	.153	57.5	59.5	.265	1.15	.149	.153	56.4	58.5	.304	1.15	.158	.175	56.5	58.4	.308	1.53	.184	.191	61.2	.198	4.58	-----
9	56.6	61.0	.269	.52	.082	.135	57.0	59.9	.262	.52	.122	.131	56.8	59.6	.318	.52	.135	.159	56.6	58.9	.316	.81	.146	.169	57.6	.224	3.83	-----
10	59.0	60.8	.249	1.18	.110	.144	58.6	60.7	.249	1.18	.146	.144	58.2	59.4	.288	1.18	.172	.167	57.6	60.6	.318	1.77	.217	.206	62.8	.206	5.80	-----
11	48.0	58.3	.233	1.20	.122	.136	48.1	57.1	.223	1.20	.135	.130	46.9	53.2	.196	1.20	.113	.114	46.4	50.4	.154	1.84	.105	.101	43.5	.195	4.79	-----
12	40.3	55.6	.202	1.23	.070	.118	40.1	53.6	.183	1.23	.073	.107	38.4	47.8	.124	1.23	-.001	.072	37.5	41.4	.054	1.73	-.025	.035	35.1	.195	6.08	0.266
13	39.7	53.4	.167	.65	.061	.086	39.4	51.4	.144	.65	.070	.074	38.4	45.1	.077	.65	.021	.040	37.3	39.1	.024	.98	-.009	.013	39.0	.204	3.21	.040
14	48.1	53.1	.083	1.48	.033	.051	49.4	52.8	.085	1.48	.032	.052	48.1	48.6	.056	1.48	.015	.014	47.5	46.6	.036	2.27	.013	.025	49.6	.247	7.96	.057
15	42.3	51.8	.137	4.20	.068	.128	42.7	50.8	.122	4.20	.091	.114	41.6	46.9	.080	4.20	.040	.075	41.1	43.5	.051	6.34	.038	.061	38.8	.209	14.00	.432
16	42.9	49.2	.116	4.99	.096	.120	41.5	48.1	.103	4.99	.102	.106	41.8	43.8	.074	4.99	.055	.076	41.4	41.1	.054	7.33	.056	.070	43.5	.177	7.96	.108
17	43.2	49.4	.154	1.18	.055	.089	42.7	48.4	.144	1.18	.076	.083	42.3	47.1	.138	1.18	.067	.080	41.8	44.8	.122	1.66	.077	.078	42.8	.180	4.62	-----
18	42.3	49.7	.120	1.30	.047	.071	42.2	49.3	.118	1.30	.069	.070	41.6	48.4	.124	1.30	.067	.074	42.0	48.6	.124	1.91	.085	.083	43.0	.202	5.84	-----
19	44.0	51.0	.147	.76	.047	.078	44.6	50.4	.140	.76	.066	.074	43.8	49.7	.150	.76	.070	.079	43.4	46.8	.114	1.07	.082	.064	47.9	.194	4.21	.002
20	46.7	52.1	.136	.56	.050	.069	46.1	51.5	.156	.56	.070	.079	47.0	50.9	.169	.56	.074	.086	46.6	47.2	.135	.87	.091	.073	47.6	.192	6.83	-----
21	45.9	50.7	.139	3.98	.122	.126	46.7	50.1	.134	3.98	.121	.122	46.8	48.8	.134	3.98	.120	.122	47.1	46.8	.135	5.90	.160	.154	45.2	.189	7.80	-----
22	42.2	49.9	.176	.71	.064	.092	41.8	48.5	.165	.71	.081	.086	42.8	46.7	.159	.71	.082	.083	41.5	43.3	.125	1.07	.074	.071	43.1	.161	4.42	-----
23	44.5	50.8	.173	.89	.062	.094	44.4	50.1	.174	.89	.086	.095	43.3	48.3	.164	.8	.092	.089	42.6	46.7	.159	1.29	.098	.094	44.6	.148	4.88	-----
24	44.9	50.1	.171	.68	.057	.089	44.6	49.3	.164	.68	.076	.085	42.6	47.1	.161	.68	.076	.084	42.7	46.0	.165	1.11	.095	.094	44.9	.148	3.46	-----
25	44.4	49.9	.134	.75	.037	.071	44.3	49.6	.129	.75	.053	.068	43.3	47.6	.122	.75	.053	.065	43.6	48.2	.132	1.32	.067	.079	43.2	.190	3.54	.005
26	45.6	50.0	.127	.63	.044	.065	45.6	49.5	.124	.63	.063	.064	46.0	47.8	.122	.63	.061	.063	45.0	45.7	.114	1.07	.064	.065	47.4	.184	3.54	-----
27	43.4	50.5	.146	.44	.046	.072	43.6	49.8	.144	.44	.069	.071	43.0	47.8	.146	.44	.057	.072	41.8	45.8	.128	.73	.070	.067	43.2	.169	4.00	-----
28	39.6	48.9	.119	.93	.042	.065	40.5	47.7	.106	.93	.065	.058	38.1	44.6	.092	.93	.029	.051	38.2	43.0	.074	1.46	.029	.045	35.7	.184	2.08	.131
29	35.7	47.0	.120	.67	.040	.062	35.6	45.2	.101	.67	.047	.052	34.1	41.0	.065	.67	.019	.034	33.6	35.8	.021	1.05	-.003	.012	33.6	.176	2.75	.053
30	40.5	47.2	.100	.51	.030	.050	40.5	46.4	.091	.51	.035	.046	40.4	43.5	.077	.51	.020	.039	39.8	41.0	.052	.82	.021	.028	42.4	.190	4.37	-----
[36] 31	36.8	46.9	.094	1.70	.024	.060	39.4	46.3	.088	1.70	.053	.056	37.9	43.7	.058	1.70	.036	.037	38.1	43.5	.050	2.70	.008	.038	33.0	.203	12 33	.035

Nov. [37]4	27.8	41.4	.121	1.26	.033	.072	27.4	39.2	.104	1.26	.043	.062	26.4	32.8	.054	1.26	([38])	-----	26.0	32.0	.052	1.80	.037	.036	27.4	.109	3.08	[39].085
5	36.3	42.6	.097	.75	.029	.051	36.5	41.0	.089	.75	.046	.047	33.7	35.8	.047	.75	.018	.025	34.1	34.4	.036	1.12	.006	.021	38.4	.143	4.21	-----
6	36.5	43.2	.088	.49	.029	.044	36.8	41.8	.081	.49	.036	.040	35.5	39.4	.065	.49	.025	.032	34.9	37.9	.058	.94	.024	.032	39.3	.157	5.46	-----
7	38.4	42.5	.067	2.34	.036	.048	38.4	42.2	.064	2.34	.051	.046	38.4	41.0	.059	2.34	.043	.042	37.8	39.8	.051	3.34	.053	.043	38.2	.183	4.62	T.
8	38.6	42.0	.061	.74	.015	.032	39.2	41.2	.054	.74	.021	.028	38.5	39.6	.038	.74	.019	.020	38.2	38.6	.039	1.22	.016	.023	38.9	.188	3.25	.002
9	36.0	42.2	.114	1.02	.026	.064	36.4	40.1	.098	1.02	.055	.055	36.8	39.3	.083	1.02	.057	.047	34.8	39.0	.078	1.62	.062	.049	40.1	.147	4.96	.005
10	39.0	42.6	.089	.52	.025	.045	39.8	41.4	.056	.52	.037	.028	39.0	39.8	.084	.52	.033	.042	39.1	40.7	.092	.93	.043	.051	42.2	.138	3.79	-----
11	42.0	42.6	.096	1.43	.040	.058	42.5	42.8	.102	1.43	.071	.062	40.9	41.2	.104	1.43	.067	.063	41.0	42.1	.115	2.00	.088	.078	43.6	.128	5.38	-----
12	39.3	42.9	.094	.24	.029	.044	39.1	41.0	.079	.24	.026	.037	37.9	39.6	.084	.24	.030	.039	38.5	40.5	.090	.58	.038	.046	39.6	.141	2.92	-----
13	43.1	43.1	.094	1.20	.024	.055	43.5	42.6	.091	1.20	.046	.053	43.0	40.2	.074	1.20	.041	.043	43.6	41.0	.088	1.87	.055	.058	44.6	.151	12.21	-----
14	47.0	42.5	.105	4.89	.131	.107	48.0	42.8	.110	4.89	.162	.112	48.1	42.9	.148	4.89	.149	.151	48.5	44.8	.175	6.30	.204	.207	47.4	.116	11.79	-----
15	38.6	42.1	.096	1.33	.041	.057	38.8	39.8	.081	1.33	.052	.048	39.2	38.7	.090	1.33	.053	.054	38.8	40.6	.114	2.16	.066	.079	38.0	.141	3.67	-----
16	35.9	42.1	.107	1.13	.039	.061	36.7	40.0	.092	1.13	.054	.053	36.1	38.9	.090	1.13	.054	.052	36.0	40.1	.101	1.77	.060	.066	36.4	.133	4.12	.001
17	33.0	40.8	.109	.91	.024	.060	33.0	37.8	.083	.91	.036	.045	32.2	34.0	.052	.91	.004	.028	31.7	34.3	.058	1.43	.040	.035	29.9	.129	7.67	.030
[40] 20	27.2	35.5	.090	1.85	.018	.062	27.5	33.8	.074	1.85	.020	.051	26.9	30.9	.050	1.85	([38])	-----	28.4	30.8	.052	2.73	.009	.041	27.8	.096	4.97	.064
21	34.7	36.2	.060	.85	.011	.032	34.6	36.8	.062	.85	.019	.034	33.8	31.9	.022	.85	.024	.012	34.8	31.2	.028	1.34	.052	.017	41.6	.133	4.04	-----
22	33.5	38.3	.064	.36	.011	.031	33.3	38.5	.068	.36	.018	.033	31.8	30.8	.024	.36	−.010	.011	33.7	31.5	.027	.68	−.003	.014	38.2	.128	3.33	-----
23	37.8	39.0	.079	.72	.022	.042	37.4	38.4	.074	.72	.036	.039	37.6	31.8	.029	.72	.046	.015	37.5	31.9	.033	1.17	.035	.019	41.8	.132	4.46	-----
24	33.3	39.6	.076	.62	.026	.039	33.3	38.5	.071	.62	.037	.036	32.9	31.5	.027	.62	.024	.014	33.9	32.1	.031	.90	.020	.017	33.3	.126	4.08	-----
25	33.3	39.8	.079	.41	.026	.039	33.2	38.1	.064	.41	.031	.031	31.4	31.6	.028	.41	.011	.014	31.4	33.5	.041	.93	.022	.023	33.5	.134	2.33	-----
26	36.9	40.1	.068	.56	.025	.034	37.0	39.1	.064	.56	.033	.032	36.1	31.9	.031	.56	.015	.016	37.2	36.3	.042	1.00	.028	.023	42.0	.142	3.54	-----
[41] 27	34.7	39.2	.077	.49	.022	.038	35.2	38.4	.068	.49	.031	.034	33.9	32.0	.035	.49	.017	.017	33.4	34.0	.050	.98	.015	.028	35.8	.126	5.04	-----

[1] Ground wind here refers to the wind at the elevation of the top of the tank.
[2] Data taken from Colorado Agricultural Experiment Station weather record. Air temperature is the mean of maximum and minimum reading for the day. Vapor pressure is the mean of the 7 a. m. and 7 p. m. readings. Tower wind record is from 7 a. m. to 7 a. m.
[3] Dry-bulb temperature.
[4] Wind splashing water out of reservoir.
[5] Record discontinued from 11.17 p. m. Oct. 28 to 5.18 p. m. Oct. 29 on account of flooded tanks. For the remainder of 1926, record day is from 6 p. m. to 6 p. m.
[6] Time interval, 2,826 minutes.
[7] Time interval, 4,257 minutes.
[8] Time interval, 5,701 minutes.
[9] Mean for period Nov. 16, 17, 18, and 19.
[10] Record discontinued on account of ice.
[11] Means based on estimated water temperature at 7 a. m. Nov. 22. Thermometer crushed in ice.
[12] Mean for period Nov. 20, 21, and 22.
[13] Mean for period Nov. 24 and 25.
[14] Tanks drained on Nov. 26 to straighten floating tank support.
[15] Repaired bridge anemometer; previous record discarded.
[16] Observations discontinued on account of storm.
[17] Splashed full during forenoon; assumed equal to average for the day.
[18] Psychrometer out of adjustment in forenoon; values estimated.
[19] Two-day average on account of storm.
[20] Vapor pressure partly estimated; psychrometer not operating.
[21] Tanks emptied and cleaned.
[22] One period excluded on account of splashing rain; rate assumed equal to average of other three periods.
[23] Partly estimated; psychrometer out of adjustment during one period.
[24] Beginning with this date record is from 6 p. m. to 6 p. m.
[25] Record discontinued on account of storm.
[26] One-third of 3-day total.
[27] Record discarded; snow blew into tanks.
[28] From Colorado Agricultural Experiment Station weather record.
[29] Started taking additional observations at 1 p. m.
[30] Period of heaviest rain excluded.
[31] Partly estimated; thermometer wet part of the time.
[32] Tank flooded.
[33] All tanks drained and cleaned July 31.
[34] Evaporation increased 0.040 inch for effect of filling reservoir.
[35] Partly estimated; no water temperature record for 7 a. m. Aug. 17.
[36] Data, with exception of Colorado Agricultural Experiment Station weather record, based on one-half day period on account of storm.
[37] Mean data on account of ice for 4-day period except U. S. Weather Bureau land tank, which is for 5-day period.
[38] No record; tank blew full of snow.
[39] From Colorado Agricultural Experiment Station weather record.
[40] Mean record for 3-day period on account of ice.
[41] Observations discontinued on account of snow storm.

The computed evaporation was obtained by substituting the mean ground-wind velocity and the weighted mean difference in vapor pressure in formula 10,

$$E=(1.465-0.0186\ B)\ (0.44+0.118\ W)\ (e_s-e_d) \qquad (10)$$

This formula was derived from experiments under controlled conditions in the laboratory at Fort Collins, and under natural conditions at different altitudes at points in the West (p. 42). The altitude factor $(1.465-0.0186B)$ is unity at Fort Collins, as is shown by sub-

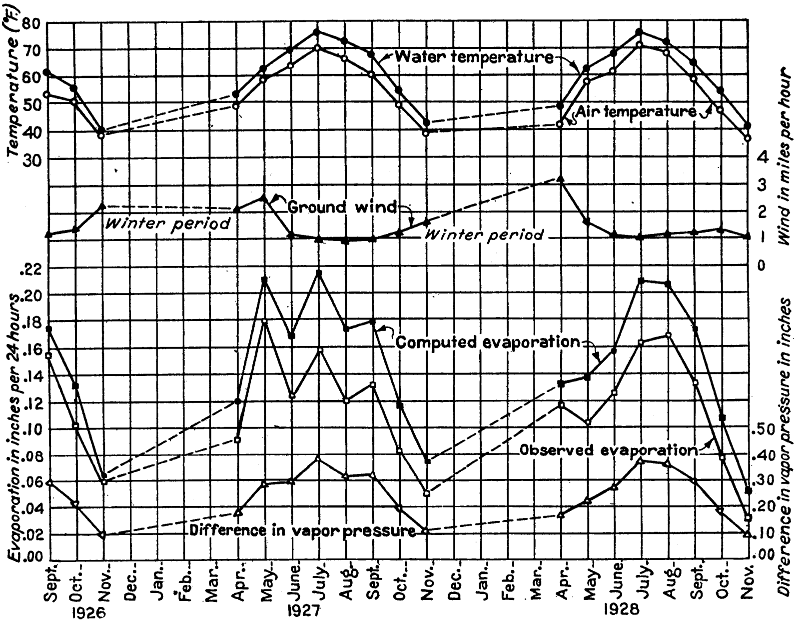


FIGURE 10.—Relation between observed and computed evaporation, and variation of evaporation with wind and difference in vapor pressure in 85-foot circular reservoir, Fort Collins, Colo. (Evaporation computed by formula 10)

stituting for B the normal barometer reading of 24.990 inches at 32° F. The formula then becomes

$$E=(0.44+0.118\ W)\ (e_s-e_d)$$

which is formula 6 derived from controlled-wind experiments in the laboratory.

In Table 14 the observed evaporation is the total loss that occurred in the 24-hour period. In case of rain or snow the measured loss was increased by the amount of the precipitation. During periods of heavy precipitation, especially of snow, and of severe wind storms, it was necessary to discard the evaporation record for that period on account of unavoidable errors under those circumstances. It was assumed that the rate of evaporation during the period was the same as the average rate during the remaining periods of the day.

The meteorological data from the Colorado Agricultural Experiment Station record are given for comparison with the records taken at the evaporation tanks. The daily records are not strictly com-

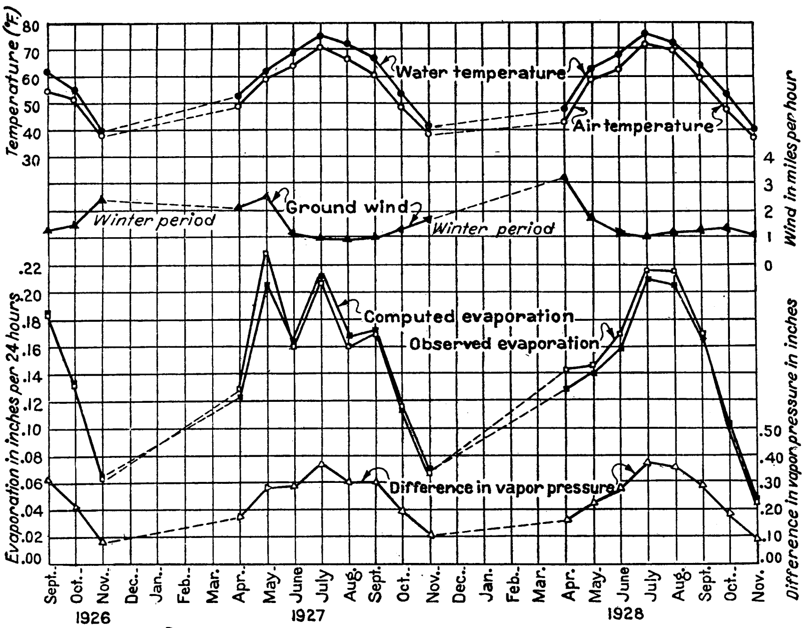


FIGURE 11.—Relation between observed and computed evaporation, and variation of evaporation with wind and difference in vapor pressure in Geological Survey tank, Fort Collins, Colo. (Evaporation computed by formula 10)

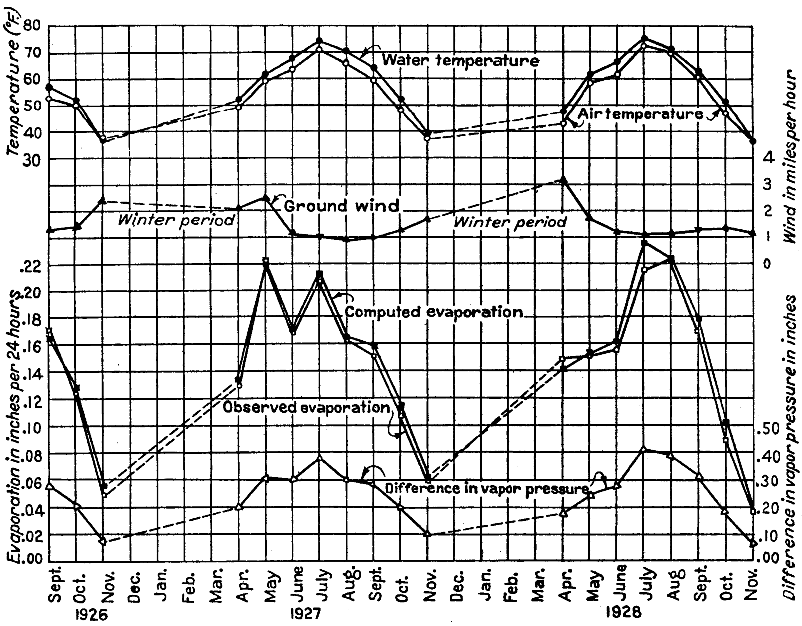


FIGURE 12.—Relation between observed and computed evaporation, and variation of evaporation with wind and difference in vapor pressure in Colorado tank, Fort Collins, Colo. (Evaporation computed by formula 10)

parable because of differences in the hours at which the 24-hour periods ended. These differences, however, are negligible when monthly means are considered.

The standard Weather Bureau practice was observed in taking the experiment station records, readings being taken at 7 a. m. and 7 p. m. daily. The instrument shelter is in a plot on the college lawn and is approximately 6 feet above the ground, but the anemometer is located at the top of the civil engineering building, 67.5 feet above the ground.

Table 15 is a summary by months of the data given in Table 14, and the results for each of the tanks and for the reservoir are shown in Figures 10 to 13, inclusive. These graphs show clearly the relation between the observed and computed evaporation, as well as the

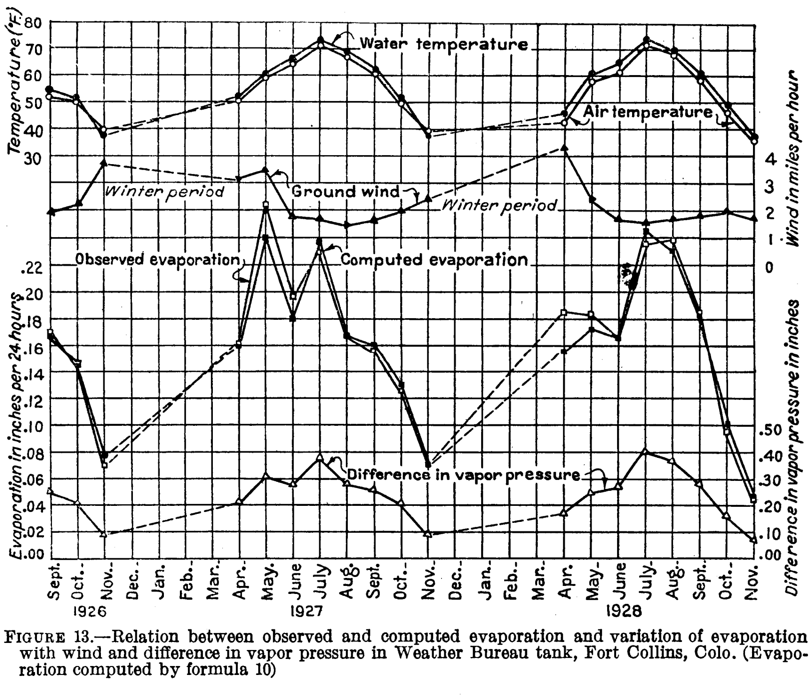


FIGURE 13.—Relation between observed and computed evaporation and variation of evaporation with wind and difference in vapor pressure in Weather Bureau tank, Fort Collins, Colo. (Evaporation computed by formula 10)

variation of the evaporation with the wind and with the difference in vapor pressure. It will be observed that in only two instances—both in November—do the monthly mean water temperatures drop below the monthly mean air temperatures. The evaporation curves follow the temperature curves in a general way, but whenever there are unusual changes in wind or differences in vapor pressure the evaporation follows these factors rather than the temperature.

The monthly mean values were not corrected for the variations in the time intervals but were obtained by dividing the totals for each month by the number of days recorded in Table 14 for that month. Periods extending over several days were counted as one day, because the records during those periods were usually inaccurate and giving them additional weight would tend to decrease the accuracy of the mean values.

TABLE 15.—*Monthly mean evaporation as observed and as computed from formula 10 at Fort Collins, Colo. (elevation 5,000 feet, barometric pressure 24.990 inches), from circular reservoir and various standard tanks, and pertinent monthly mean meteorological data*

Month and year	Reservoir						Geological Survey floating tank						Colorado land tank						Weather Bureau land tank, class A						Meteorological data (monthly mean values)			
	Meteorological data (monthly mean values)				Monthly mean evaporation in 24 hours		Meteorological data (monthly mean values)				Monthly mean evaporation in 24 hours		Meteorological data (monthly mean values)				Monthly mean evaporation in 24 hours		Meteorological data (monthly mean values)				Monthly mean evaporation in 24 hours					
	Temperatures: Air	Temperatures: Water	Difference in vapor pressure, e_s-e_d	Velocity of wind at ground	Observed	Computed	Temperatures: Air	Temperatures: Water	Difference in vapor pressure, e_s-e_d	Velocity of wind at ground	Observed	Computed	Temperatures: Air	Temperatures: Water	Difference in vapor pressure, e_s-e_d	Velocity of wind at ground	Observed	Computed	Temperatures: Air	Temperatures: Water	Difference in vapor pressure, e_s-e_d	Velocity of wind at ground [1]	Observed	Computed	Air temperature [2]	Air vapor pressure [2]	Velocity of wind at tower [2]	Total monthly precipitation
	° F.	° F.	Inch of mercury	Miles per hour	Inch	Inch	° F.	° F.	Inch of mercury	Miles per hour	Inch	Inch	° F.	° F.	Inch of mercury	Miles per hour	Inch	Inch	° F.	° F.	Inch of mercury	Miles per hour	Inch	Inch	° F.	Inch of mercury	Miles per hour	Inches
1926																												
Sept	53.36	61.60	0.2996	1.273	0.1551	0.1750	53.96	61.37	0.3164	1.273	0.1825	0.1854	52.75	56.84	0.2766	1.273	0.1695	0.1643	51.57	53.98	0.2462	1.895	0.1703	0.1671	52.28	0.1896	5.559	0.074
Oct	50.32	55.20	.2182	1.429	.1034	.1326	50.59	54.52	.2181	1.429	.1335	.1311	49.71	51.65	.2086	1.429	.1239	.1273	49.90	50.37	.2055	2.221	.1436	.1460	50.56	.1720	5.583	.297
Nov	38.31	39.90	.0909	2.276	.0596	.0642	38.48	39.04	.0873	2.395	.0634	.0645	37.04	36.50	.0720	2.408	.0489	.0554	38.74	36.92	.0817	3.705	.0691	.0770	40.16	.1295	8.354	.329
1927																												
Apr	48.78	52.94	.1754	2.139	.0920	.1205	48.90	52.55	.1789	2.139	.1291	.1229	49.34	52.20	.1968	2.139	.1293	.1330	50.50	51.48	.2042	3.124	.1617	.1591	47.23	.1822	7.092	1.844
May	58.68	62.32	.2868	2.521	.1795	.2101	59.05	61.61	.2824	2.521	.2286	.2060	59.16	61.54	.3075	2.521	.2230	.2187	59.59	59.90	.3019	3.445	.2641	.2404	56.29	.2188	9.148	.951
June	63.32	69.12	.2906	1.171	.1245	.1681	63.58	68.32	.2854	1.171	.1610	.1651	63.33	67.22	.2930	1.171	.1679	.1699	63.93	65.91	.2757	1.741	.1958	.1800	62.22	.3660	5.343	2.190
July	69.92	75.78	.3867	1.003	.1594	.2163	70.24	74.60	.3729	1.003	.2085	.2121	70.59	73.46	.3799	1.003	.2071	.2127	70.79	72.45	.3738	1.618	.2302	.2366	67.48	.4224	4.723	1.404
Aug	66.00	72.31	.3156	.912	.1207	.1729	66.02	71.66	.3071	.912	.1603	.1681	65.71	69.91	.3005	.912	.1617	.1643	66.52	68.45	.2755	1.447	.1669	.1676	64.10	.4167	4.044	1.521
Sept	60.36	67.79	.3217	.999	.1323	.1789	60.14	66.76	.3061	.999	.1708	.1719	59.36	63.74	.2835	.999	.1518	.1577	60.24	61.60	.2568	1.618	.1560	.1613	58.86	.3041	4.511	1.380
Oct	49.02	53.94	.1985	1.271	.0826	.1171	48.65	53.57	.1979	1.271	.1147	.1159	47.90	51.90	.1974	1.271	.1067	.1146	48.87	51.27	.2010	1.964	.1265	.1296	50.15	.1779	5.326	.942
Nov	38.80	42.62	.1135	1.668	.0510	.0745	38.51	41.11	.1035	1.668	.0668	.0688	37.49	38.66	.0921	1.668	.0592	.0627	38.66	38.02	.0870	2.415	.0714	.0703	40.62	.1335	5.894	.907
1928																												
Apr	42.35	48.74	.1628	3.207	.1174	.1332	42.97	47.60	.1555	3.207	.1431	.1283	42.43	47.06	.1724	3.207	.1492	.1416	42.26	45.39	.1672	4.300	.1855	.1558	42.24	.1396	8.604	.972
May	58.01	62.74	.2185	1.693	.1042	.1372	58.74	62.56	.2236	1.693	.1459	.1406	58.62	61.58	.2417	1.693	.1501	.1511	57.81	60.86	.2485	2.367	.1837	.1731	55.71	.2923	6.021	3.401
June	61.37	67.91	.2719	1.156	.1254	.1567	62.26	67.50	.2747	1.156	.1687	.1583	61.56	65.98	.2767	1.156	.1552	.1609	60.78	64.50	.2641	1.660	.1654	.1662	57.28	.3302	5.424	2.933
July	71.15	75.80	.3686	1.074	.1627	.2089	71.78	75.30	.3689	1.074	.2165	.2095	72.31	74.66	.4112	1.074	.2147	.2365	71.57	73.47	.3946	1.536	.2348	.2447	67.75	.4336	5.086	1.054
Aug	68.41	72.37	.3588	1.156	.1678	.2071	69.49	71.74	.3555	1.156	.2150	.2050	69.62	70.67	.3894	1.156	.2227	.2229	68.56	68.97	.3651	1.677	.2371	.2307	66.20	.3465	5.056	.735
Sept	58.64	64.65	.2975	1.227	.1321	.1725	59.15	63.59	.2816	1.227	.1685	.1651	60.26	62.19	.3072	1.227	.1692	.1780	58.62	60.34	.2790	1.778	.1835	.1813	58.53	.2465	5.700	.113
Oct	46.95	53.93	.1828	1.313	.0760	.1072	47.07	53.06	.1762	1.313	.0996	.1031	46.54	50.73	.1753	1.313	.0885	.1016	46.02	48.62	.1563	1.954	.0951	.1009	47.02	.1909	5.452	1.136
Nov	36.50	40.92	.0878	1.096	.0310	.0507	36.71	39.79	.0786	1.096	.0437	.0457	35.91	36.16	.0599	1.096	.0360	.0368	36.06	36.69	.0660	1.673	.0441	.0457	38.09	.1373	4.951	.187
Mean	54.75	60.03	.2445	1.504	.1158	.1502	55.07	59.28	.2406	1.511	.1507	.1477	54.72	57.51	.2443	1.511	.1466	.1509	54.78	56.27	.2342	2.218	.1653	.1626	53.83	.2542	5.888	-----

[1] In the case of the U. S. Weather Bureau class A land tank, the ground wind refers to the wind at the elevation of the top of the tank.
[2] Data taken from Colorado Agricultural Experiment Station weather records.

A study of Table 14 shows that with few exceptions the daily mean temperature of the water in the standard tanks and the reservoir was higher than that of the air, and this is true whether the seasonal temperature was rising or falling. The only exceptions occurred during sudden rises in temperature and during periods when the tanks were ice covered, because so long as the ice remains its temperature can not exceed 32° F. The monthly mean water temperatures (Table 15) were also higher than the monthly mean air temperatures, although two exceptions occurred in November, 1926—one in the case of the Colorado tank and one in the case of the Weather Bureau tank.

Table 14 also shows that the maximum observed evaporation occurred during periods of high wind, and that for periods of constant wind evaporation increased as the difference in vapor pressure increased, regardless of the temperature of the air. For periods of heavy precipitation, particularly snow, the results are erratic. The Colorado tank was influenced by precipitation more than the others. Being in the ground it caught the drifting snow, and apparently while rain was falling more splashed into the tank than splashed out. The monthly mean observed evaporation from each tank increased as the temperature increased, except in a few cases when the difference in vapor pressure did not increase with the temperature or the monthly mean wind velocity decreased more rapidly than usual.

The daily evaporation from the standard tanks as computed from formula 10 agreed quite closely with the observed evaporation except during stormy weather, but the computed evaporation from the reservoir was almost without exception larger than the observed evaporation. The only exceptions were during periods of strong wind and stormy weather. The computed values based on the 7 a. m. and 7 p. m. readings, during the first two weeks in April, 1928, are considerably in error and show that readings taken at these hours did not give the true mean for the day. The results were improved when an additional set of observations was taken at 1 p. m. The monthly mean values of the computed and observed evaporation from the standard tanks agreed more closely than the daily values, but in the case of the reservoir the monthly mean evaporation as computed was higher than the observed figure. This is to be expected, because the formula is based on observations made on a tank 3 feet square in which the rim effect (*30*) is proportionately much greater than in a large reservoir.

Table 16 gives the observed and computed evaporation by months from the reservoir and standard tanks, the percentage of deviation of these values, and the ratios of the observed evaporation from each of the standard tanks to that of the reservoir. This table shows that the computed evaporation from the reservoir was consistently higher than the observed evaporation, and that the greatest deviations occurred in November, except in 1926 when the observed figure was too high because strong winds splashed the water from the reservoir before the overhanging rim around the top was built. A comparison of the weighted mean values of the observed and computed evaporation, which were obtained by dividing the total evaporation for the entire period by the number of days, shows that the computed evaporation was 29.7 per cent greater than the observed.

TABLE 16.—*Comparison of the evaporation as observed and as computed from formula 10, at Fort Collins, Colo. (elevation, 5,000 feet, barometric pressure 24.990 inches), from circular reservoir and the various standard tanks, and the ratio of the observed evaporation from the various standard tanks to that from the circular reservoir*

Month and year	Days of record	Reservoir: Mean evaporation per 24 hours: Observed	Reservoir: Mean evaporation per 24 hours: Computed	Reservoir: Deviation	Geological Survey floating tank: Mean evaporation per 24 hours: Observed	Geological Survey floating tank: Mean evaporation per 24 hours: Computed	Geological Survey floating tank: Deviation	Geological Survey floating tank: Ratio of observed evaopration to that from reservoir	Colorado land tank: Mean evaporation per 24 hours: Observed	Colorado land tank: Mean evaporation per 24 hours: Computed	Colorado land tank: Deviation	Colorado land tank: Ratio of observed evaporation to that from reservoir	Weather Bureau land tank, class A: Mean evaporation per 24 hours: Observed	Weather Bureau land tank, class A: Mean evaporation per 24 hours: Computed	Weather Bureau land tank, class A: Deviation	Weather Bureau land tank, class A: Ratio of observed evaopration to that from reservoir
	Number	*Inch*	*Inch*	*Per cent*	*Inch*	*Inch*	*Per cent*		*Inch*	*Inch*	*Per cent*		*Inch*	*Inch*	*Per cent*	
1926																
September	11	0.1551	0.1750	+12.8	0.1825	0.1854	+1.6	1.177	0.1695	0.1643	−3.1	1.093	0.1703	0.1671	−1.9	1.098
October	30	.1034	.1326	+28.2	.1335	.1311	−1.8	1.291	.1239	.1273	+2.7	1.198	.1436	.1460	+1.7	1.389
November	22	[1] .0596	[1] .0642	+7.7	.0634	.0645	+1.7	1.064	.0489	.0554	+13.3	.820	.0691	.0770	+11.4	1.159
1927																
April	20	.0920	.1205	+31.0	.1291	.1229	−4.8	1.403	.1293	.1330	+2.9	1.405	.1617	.1591	−1.6	1.758
May	31	.1795	.2101	+17.0	.2286	.2060	−9.9	1.274	.2230	.2187	−1.9	1.242	.2641	.2404	−9.0	1.471
June	29	.1245	.1681	+35.0	.1610	.1651	+2.5	1.293	.1679	.1699	+1.2	1.349	.1958	.1800	−8.1	1.573
July	29	.1594	.2163	+35.7	.2085	.2121	+1.7	1.308	.2071	.2127	+2.7	1.299	.2302	.2366	+2.8	1.444
August	31	.1207	.1729	+43.2	.1603	.1681	+4.9	1.328	.1617	.1643	+1.6	1.340	.1669	.1676	+0.4	1.383
September	30	.1323	.1789	+35.2	.1708	.1719	+0.6	1.291	.1518	.1577	+3.9	1.147	.1560	.1613	+3.4	1.179
October	31	.0826	.1171	+41.8	.1147	.1159	+1.0	1.389	.1067	.1146	+7.4	1.292	.1265	.1296	+2.5	1.531
November	29	.0510	.0745	+46.1	.0668	.0688	+3.0	1.310	.0592	.0627	+5.9	1.161	.0714	.0703	−1.5	1.400
1928																
April	26	[2] .1174	[2] .1332	+13.5	.1431	.1283	−10.3	1.219	[2] .1492	[2] .1416	−5.1	1.271	.1855	.1558	−16.0	1.580
May	31	.1042	.1372	+31.7	.1459	.1406	−3.6	1.400	.1501	.1511	+0.7	1.440	.1837	.1731	−5.8	1.763
June	30	.1254	.1567	+25.0	.1687	.1583	−6.2	1.345	[3] .1552	[3] .1609	+3.7	1.238	.1654	.1662	+0.5	1.319
July	30	.1627	.2089	+28.4	.2165	.2095	−3.2	1.331	.2147	.2365	+10.1	1.320	.2348	.2447	+4.2	1.443
August	31	.1678	.2071	+23.4	.2150	.2050	−4.7	1.281	.2227	.2229	+0.1	1.327	.2371	.2307	−2.7	1.413
September	30	.1321	.1725	+30.6	.1685	.1651	−2.0	1.276	.1692	.1780	+5.2	1.281	.1835	.1813	−1.2	1.389
October	31	.0760	.1072	+41.1	.0996	.1031	+3.5	1.311	.0885	.1016	+14.8	1.164	.0951	.1009	+6.1	1.251
November	22	.0310	.0507	+63.5	.0437	.0457	+4.6	1.410	[1] .0360	[1] .0368	+2.2	1.161	.0441	.0457	+3.6	1.423
Weighted mean		.1158	.1502	+29.7	.1507	.1477	−2.0	1.301	.1466	.1509	+2.9	1.266	.1653	.1626	−1.6	1.427

[1] 21-day record. [2] 25-day record. [3] 29-day record.

Comparisons of the results from the standard tanks by months show that, in general, the computed values are quite close to the observed values, though in some cases the computed values are too high, and in others too low. The weighted means for the entire period agree remarkably well, the computed evaporation from the Geological Survey floating tank being 2 per cent low, that from the Colorado tank 2.9 per cent high, and that from the Weather Bureau land tank 1.6 per cent low.

An interesting fact is that the evaporation from the Geological Survey floating tank was almost identical with that from the Colorado land tank. This seems unusual, but it was observed in compiling the original notes that the ground wind computed from the bridge anemometer record was generally higher than that computed from the other two anemometers. If the wind was higher at the Geological Survey tank than at the Colorado tank, it may have increased the evaporation sufficiently to overshadow the effect of the smaller difference in vapor pressure in the center of the reservoir.

One purpose of these evaporation experiments was to determine the relation between evaporation from the standard tanks and that from the circular reservoir. Experiments by Sleight mentioned in a discussion of Houk's paper (*20, p. 303–316*) at Denver, Colo., on the evaporation under similar conditions from tanks sunk 3 feet deep and varying in diameter from 1 to 12 feet, indicated that evaporation decreased as the diameter of the tank increased, but that the decrease was small as between the 9-foot and 12-foot tanks. From this Sleight concluded that evaporation from a reservoir or lake probably did not differ materially from that from a tank 12 feet in diameter and similarly exposed. The observations at Fort Collins were made on a reservoir 85 feet in diameter. If there was no decrease in the rate of evaporation from this reservoir, as shown by a comparison with the standard evaporation tanks, it seems reasonable to conclude that the evaporation from a tank 12 feet in diameter would be the same as that from a reservoir or lake.

The experiments at Fort Collins (Table 16) showed that the observed average mean evaporation from the Geological Survey floating tank was 30.1 per cent, from the Colorado buried tank 26.6 per cent, and from the Weather Bureau land tank 42.7 per cent greater than that from the 85-foot circular reservoir. Sleight found that the evaporation from tanks of these same types was, respectively, 12.5 per cent, 25.9 per cent, and 42.1 per cent greater than that from a 12-foot tank.

Observations by the Geological Survey (*34*) at Milford, Utah, at approximately 5,000 feet above sea level, showed that evaporation from a Weather Bureau class A land pan was 47 per cent greater than that from a 12-foot circular tank. Experiments made at Austin, Tex. (*15*), on a Geological Survey floating tank and a Weather Bureau class A land pan, agree with Sleight's observations at Denver.

The agreement in these observations is close, except in the case of the Geological Survey floating tanks where the inconsistency is probably due to the difference in exposure of the two tanks. The floating tank at Fort Collins was located in the center of the 85-foot circular reservoir, whereas the one at Denver was located in Washington Park Lake, an artificial reservoir 17 acres in area, which was more than a half mile from the other tanks. The fact that the floating tank in

Washington Park Lake was surrounded by a raft (*30*) may have had some effect because the raft would reduce the wind velocity. The ratios for the Colorado tank and the Weather Bureau tank show, however, that there is no significant decrease in the evaporation from the 85-foot reservoir as compared with that from a 12-foot tank.

From the foregoing it is reasonable to conclude that evaporation from a lake or large reservoir is substantially the same as that from a tank 12 feet in diameter, and that the respective ratios of evaporation from either the Colorado tank or the Weather Bureau tank, to that from the 85-foot reservoir, may be used in computing the evaporation from a lake or large reservoir if evaporation records for one of these tanks under similar conditions are available.

OBSERVATIONS AT EAST PARK RESERVOIR, STONYFORD, CALIF.[5]

To check the ratios as found to apply between the evaporation from standard evaporation pans and that from the 85-foot circular reservoir at Fort Collins, Colo., by observations on a larger reservoir as well as to test the evaporation formulas previously developed, observations were made during the summer of 1930 at Stonyford, Calif., on the evaporation from East Park Reservoir and from various types of evaporation pans.

East Park Reservoir is located in northern California on Little Stony Creek. (Fig. 14.) It is a part of the storage system of the Orland project of the United States Bureau of Reclamation. The reservoir has a maximum capacity of 51,000 acre-feet and a high-water area of nearly 1,800 acres. The dam, in a narrow gorge at the lower end of a rock valley, is of concrete and is founded on bed rock which makes a practically water-tight basin. Several small streams empty into the reservoir, but the inflow is small during the late summer. A canal connecting the reservoir with Stony Creek proper diverts water from the creek

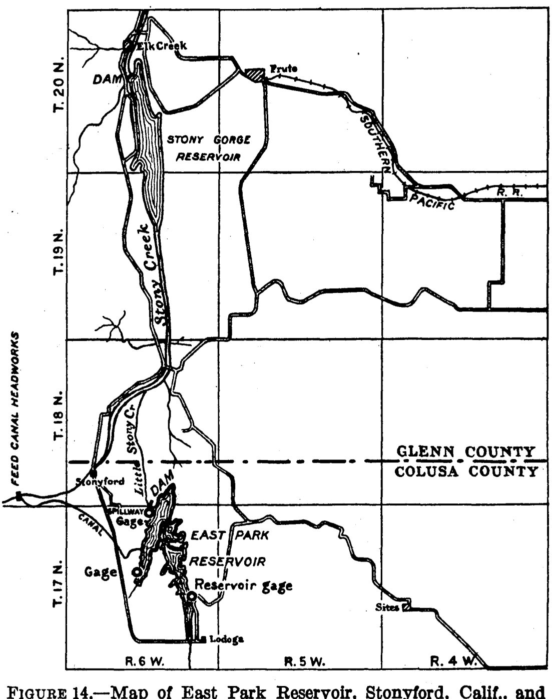


FIGURE 14.—Map of East Park Reservoir, Stonyford, Calif., and adjacent area, showing locations of reservoir gages

[5] The experiments at East Park Reservoir were conducted under informal cooperation by several interested parties and were originally discussed and finally sponsored by the special committee on irrigation hydraulics of the American Society of Civil Engineers. Contributions in the form of salaries, transportation, materials, and labor were made by the Division of Agricultural Engineering, Bureau of Public Roads, U. S. Department of Agriculture; the Bureau of Reclamation of the U. S. Department of the Interior; and the Division of Water Resources of the California State Department of Public Works.

during the high-water season but is not used during the summer. Rain seldom falls in the summer, and evaporation figures therefore do not need to be corrected for precipitation.

Stony Gorge Reservoir of the Orland project is located in the channel of Stony Creek below the East Park Reservoir (fig. 14), and consequently when the flow of the creek supplemented by Stony Gorge Reservoir is sufficient to supply the project, it is not necessary to draw water from East Park Reservoir. Under these conditions, which existed in the summer of 1930, the reservoir is suitable for making evaporation observations.

Before starting the observations it was necessary to draw down the reservoir level below the top of the flashboards because there was some leakage through the flashboards and considerable water splashed over the crest when the wind was blowing. The reservoir accordingly was lowered 1.9 feet. On June 26 the gates were closed, and as observations were not started until July 14 ample opportunity was afforded for the bank storage to adjust itself.

The evaporation pans were installed on the shore of the reservoir near the north end of the spillway. This site was considered representative of the average conditions around the reservoir. The pans consisted of a Colorado sunken pan 3 feet square and 18 inches deep, a circular sunken pan 4 feet in diameter and 3 feet deep, a Weather Bureau class A land pan and a circular floating pan 4 feet in diameter and 10 inches deep. These pans are shown in Plate 10, A and B.

The Colorado pan was sunk in the ground within approximately 1 inch of the top. The maximum water level was 1½ inches and the minimum 2½ inches below the top of the pan.

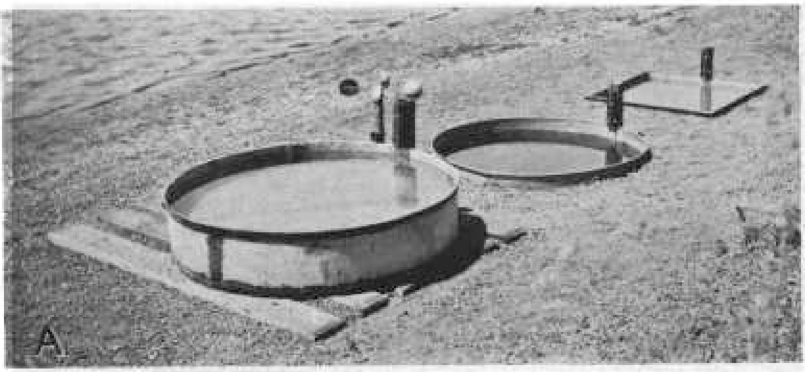
The 4-foot circular sunken pan was so placed in the ground that 3 inches of the rim extended above the ground. The water level was kept at approximately the ground surface, and as soon as the surface had dropped 1 inch the pan was refilled.

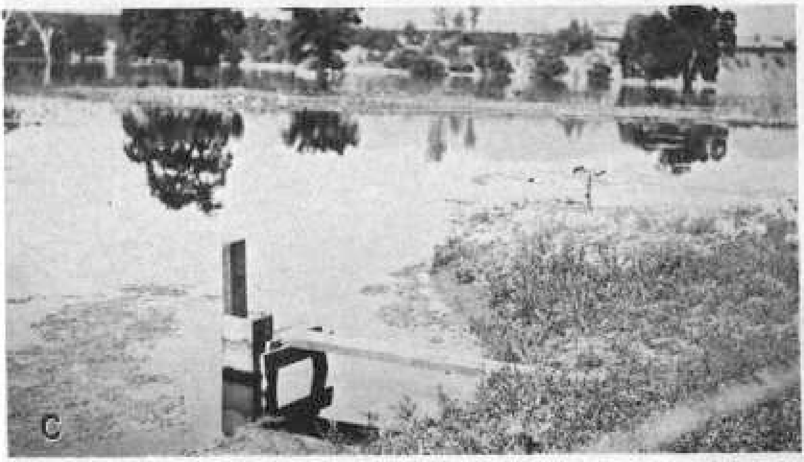
The Weather Bureau pan was installed on a grillage of timbers with the top of the pan 12 inches above the ground. The maximum water surface was 1½ inches and the minimum 2½ inches below the top of the pan.

The floating pan was identical with the Weather Bureau pan, except that it was supported on a timber frame approximately 5 feet square which floated within a raft 11 feet square made of 3 by 12 inch timbers. (Pl. 10, B.) The timber frame supporting the pan was surrounded by a barrier of 1 by 12 inch boards which extended 5 inches above the top of the pan. This barrier prevented water from splashing into the pan from the reservoir during heavy winds. The top of the pan was 3 inches above the reservoir surface, and the water level within the pan was kept within a minimum of approximately 2½ inches and a maximum of 4½ inches below the top of the pan.

The evaporation pans were filled with water from the reservoir which was very clear and apparently quite free from soluble salts. A sample, tested at the Colorado Agricultural College, was found to contain only 143 parts per million of solids.

Hook gages of the Hoff type, reading to one one-hundredth of an inch, were used in determining the evaporation from the pans. The gages were rigidly fixed at the sides of the tanks and were read without the use of stilling wells. Three gages were installed on the





A, Colorado-type sunken pan, circular sunken pan, and Weather Bureau land pan; B, circular floating pan and raft; C, gauge station, East Park Reservoir, Stonyford, Calif.

reservoir, one at the spillway and one on the upper end of each of the arms of the reservoir, as shown in Figure 14. The gages were thus distributed in order to obtain a more accurate value of the loss in case the wind piled the water up at one end of the reservoir. A Hoff hook gage was used at the spillway, but plumb-bob hook gages measuring from an index were used at the other points. The reservoir gages were all read to one one-thousandth of a foot, and on account of the waves a stilling well was installed at each of them. One of the reservoir gage stations is shown in Plate 10, C.

Complete meteorological records were taken at the evaporation pans and at each of the reservoir gages. These records consisted of the air and water temperatures, the wet and dry bulb temperatures, and the wind movement. The barometric pressure was taken only at the dam spillway.

The inflow and the outflow of the reservoir were quite small, but a record was kept of the measurable flow. Weirs were used when practicable, but very small flows were measured volumetrically.

No correction was made for possible seepage into the reservoir because no accurate data were available as to the amount, but since the season of 1929–30 was below normal in precipitation and since all of the streams emptying into the reservoir went dry during the period of the observations, it is assumed that the seepage was inconsiderable.

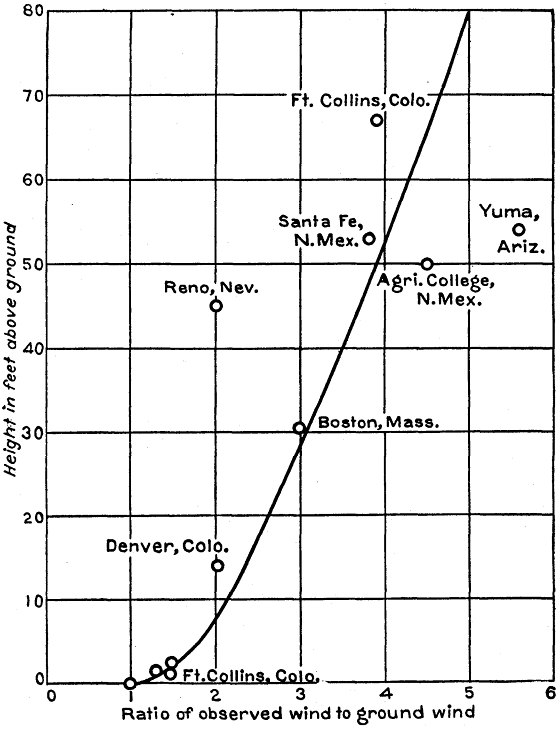


FIGURE 15.—Wind-velocity reduction diagram showing the ratios of the observed wind velocity to the ground-wind velocity at different elevations

Readings on the weirs were taken once each day but evaporation and meteorological readings were taken at 7 a. m. and 7 p. m., or as near those hours as possible considering the distance between the gages.

Observations were started on July 14 and continued until August 13, 1930, a period of 30 days. The results are given in Table 17. Only the 24-hour mean values for the period ended at 7 a. m. each day are given. This period was chosen because at 7 a. m. there was usually very little wind.

TABLE 17.—*Evaporation from East Park Reservoir and from various types of evaporation pans at Stonyford, Calif. (elevation, 1,200 feet, barometric pressure 28.9 inches), as observed and as computed, and pertinent meteorological data, 1930*

Day of month	East Park Reservoir: Meteorological data (mean values for 24 hours): Temperatures: Air	Temperatures: Water	Difference in vapor pressure, e_s-e_d	Wind velocity at water surface [1]	Reservoir loss in 24 hours	Net inflow in 24 hours [2]	Evaporation in 24 hours: Observed	Evaporation in 24 hours: Computed	Colorado-type land pan: Meteorological data (mean values for 24 hours): Temperature of water	Difference in vapor pressure, e_s-e_d	Wind velocity at water surface	Evaporation in 24 hours: Observed	Evaporation in 24 hours: Computed	Circular sunken pan: Meteorological data (mean values for 24 hours): Temperature of water	Difference in vapor pressure, e_s-e_d	Wind velocity at water surface	Evaporation in 24 hours: Observed	Evaporation in 24 hours: Computed
	°F.	°F.	*Inch of mercury*	*Miles per hour*	*Inch*	*Inch*	*Inch*	*Inch*	°F.	*Inch of mercury*	*Miles per hour*	*Inch*	*Inch*	°F.	*Inch of mercury*	*Miles per hour*	*Inch*	*Inch*
July 15	84.7	81.9	0.591	1.59	0.233	−0.001	0.232	0.266	------	------	------	------	------	81.6	0.558	2.11	0.370	0.358
July 16	85.7	81.5	.645	1.59	.352	−.004	.348	.290	------	------	------	------	------	80.9	.654	1.71	.317	.366
July 17	84.1	80.7	.665	1.50	.224	−.005	.219	.294	------	------	------	------	------	80.7	.666	1.27	.283	.366
July 18	83.9	81.6	.711	1.45	.226	−.004	.222	.312	------	------	------	------	------	80.9	.677	1.62	.358	.397
July 19	84.4	81.9	.723	1.45	.261	−.005	.256	.316	81.8	0.708	1.26	0.374	0.388	81.2	.681	1.26	.334	.373
July 20	86.9	82.4	.854	1.51	.248	−.006	.242	.378	81.4	.840	1.40	.389	.473	81.1	.820	1.40	.359	.462
July 21	87.9	83.2	.806	1.29	.273	−.031	.242	.342	81.6	.688	1.16	.351	.369	81.5	.670	1.16	.341	.360
July 22	85.8	82.2	.695	1.85	.369	−.055	.314	.328	81.6	.684	2.10	.420	.438	81.5	.674	2.10	.410	.431
July 23	83.2	81.4	.670	1.84	.351	−.051	.300	.316	81.0	.665	1.98	.375	.417	81.3	.670	1.98	.365	.420
July 24	81.0	81.3	.644	1.69	.304	−.013	.291	.295	81.1	.645	1.70	.334	.385	81.3	.642	1.70	.314	.383
July 25	81.7	81.6	.660	1.95	.209	−.009	.200	.317	81.3	.688	1.66	.360	.407	81.5	.685	1.66	.320	.405
July 26	81.1	81.5	.716	1.79	.340	−.009	.331	.343	80.3	.687	2.14	.374	.443	80.8	.695	2.14	.384	.448
July 27	77.1	80.1	.691	1.93	.350	−.008	.342	.330	78.2	.622	1.96	.393	.388	79.4	.654	1.96	.373	.408
July 28	78.0	79.9	.715	1.87	.344	−.010	.334	.338	77.5	.653	2.06	.363	.415	78.2	.672	2.06	.363	.427
July 29	74.4	78.9	.626	1.89	.323	−.010	.313	.298	77.2	.596	2.17	[4] .346	.386	78.0	.614	2.17	.346	.398
July 30	81.6	80.3	.691	1.60	.293	−.024	.269	.312	77.8	.640	2.00	.355	.403	78.2	.642	2.00	.355	.404
July 31	85.4	81.6	.769	1.91	.298	−.013	.285	.367	78.4	.694	2.36	.389	.464	78.4	.684	2.36	.368	.457
Aug. 1	86.1	81.2	.712	1.76	.273	−.011	.262	.331	78.6	.614	2.14	.388	.395	78.6	.606	2.14	.388	.390
Aug. 2	82.2	79.7	.645	1.87	.335	−.010	.325	.306	78.8	.638	2.11	.413	.409	79.0	.636	2.11	.393	.408
Aug. 3	75.4	79.1	.604	1.81	.330	−.011	.319	.283	77.6	.587	1.76	.339	.353	78.3	.602	1.76	.319	.362
Aug. 4	74.8	79.0	.588	1.67	.235	−.011	.224	.269	77.3	.558	1.94	.334	.347	78.0	.573	1.94	.323	.356
Aug. 5	78.2	79.2	.637	1.69	.303	−.011	.292	.297	77.3	.600	2.20	.372	.390	78.0	.613	2.20	.382	.399
Aug. 6	81.1	79.6	.672	1.71	.330	−.034	.296	.309	77.2	.546	2.23	.372	.357	77.8	.554	2.23	.362	.362
Aug. 7	83.1	80.5	.706	1.42	.288	−.054	.234	.308	78.8	.605	1.74	.334	.363	79.1	.603	1.74	.314	.362
Aug. 8	84.1	79.8	.615	2.15	.363	−.054	.309	.306	78.6	.524	3.32	.409	.405	78.7	.522	3.32	.379	.404
Aug. 9	78.4	79.2	.566	1.70	.305	−.011	.294	.244	78.8	.588	1.80	.346	.357	79.0	.585	1.80	.325	.355
Aug. 10	77.1	79.6	.561	1.61	.229	−.011	.218	.253	79.3	.573	1.95	.308	.357	79.2	.562	1.95	.318	.350
Aug. 11	83.0	80.7	.636	1.50	.198	−.011	.187	.282	79.4	.604	2.09	.360	.386	79.7	.606	2.09	.320	.387
Aug. 12	85.6	80.6	.669	1.41	.288	−.011	.277	.292	80.2	.677	1.80	.372	.410	80.3	.674	1.80	.372	.409
Aug. 13	87.6	81.6	.687	1.27	.217	−.011	.206	.291	81.1	.704	1.41	.328	.397	80.8	.687	1.41	.309	.387
Total	2,463.6	2,421.8	20.170	50.27	8.692	------	8.183	9.213	2,062.2	16.628	50.44	9.498	10.302	2,393.0	19.181	57.15	10.464	11.794
Mean	82.12	80.72	.672	1.676	.2897	------	.2728	.3071	79.32	.6395	1.94	.3653	.3962	79.77	.6393	1.905	.3488	.3931

Day of month	Weather Bureau class A land pan						Floating tank					
	Meteorological data (mean values for 24 hours)				Evaporation in 24 hours		Meteorological data (mean values for 24 hours)				Evaporation in 24 hours	
	Temperatures		Difference in vapor pressure, e_s-e_d	Wind velocity at water surface	Observed	Computed	Temperatures		Difference in vapor pressure, e_s-e_d	Wind velocity at water surface	Observed	Computed
	Air [3]	Water					Air	Water				
	°F.	°F.	*Inch of mercury*	*Miles per hour*	*Inch*	*Inch*	°F.	°F.	*Inch of mercury*	*Miles per hour*	*Inch*	*Inch*
July 15	84.5	78.7	0.524	2.95	0.468	0.384	85.0	81.9	0.522	1.97	0.360	0.326
July 16	82.9	76.6	.554	2.39	.368	.372	82.9	78.8	.583	1.59	.307	.341
July 17	81.0	75.7	.547	1.78	.352	.331	81.2	78.5	.582	1.19	.283	.314
July 18	79.9	74.8	.520	2.27	.454	.342	79.7	78.5	.590	1.51	.356	.339
July 19	80.8	76.3	.570	1.77	.388	.344	80.9	79.0	.642	1.18	.324	.346
July 20	81.8	76.4	.731	1.96	.407	.456	82.0	78.7	.750	1.31	.369	.415
July 21	82.6	76.8	.580	1.63	.397	.341	82.5	79.5	.572	1.09	.361	.302
July 22	81.2	75.4	.518	2.94	.492	.379	81.3	78.8	.582	1.96	.359	.363
July 23	79.7	75.2	.510	2.77	.402	.364	79.7	78.6	.558	1.85	.365	.342
July 24	77.7	75.2	.484	2.38	.366	.324	77.8	78.6	.530	1.59	.335	.309
July 25	79.1	75.6	.536	2.32	.396	.356	79.3	79.1	.596	1.55	.320	.345
July 26	77.8	73.8	.514	3.00	.401	.380	77.4	78.1	.582	2.00	.354	.366
July 27	74.4	70.4	.420	2.75	.375	.299	74.0	77.2	.588	1.83	.383	.359
July 28	74.4	70.2	.480	2.89	.375	.348	74.2	77.0	.603	1.93	.393	.374
July 29	73.8	70.5	.440	3.04	[4] .366	.327	73.4	76.7	.560	2.03	.387	.354
July 30	78.0	73.2	.538	2.80	.396	.386	78.0	77.8	.634	1.87	.386	.389
July 31	80.4	73.9	.600	3.31	.407	.463	80.8	78.0	.677	2.21	.359	.441
Aug. 1	81.4	72.7	.464	3.00	.453	.343	81.2	77.8	.534	2.00	.366	.336
Aug. 2	78.1	72.4	.473	2.96	.460	.347	78.0	76.9	.564	1.97	[5] .390	.353
Aug. 3	71.5	70.4	.407	2.46	.335	.276	71.7	76.2	.523	1.64	.336	.308
Aug. 4	71.1	69.8	.373	2.71	.340	.264	71.7	76.1	.504	1.81	.334	.306
Aug. 5	74.8	70.4	.436	3.08	.409	.326	75.1	76.2	.546	2.05	.349	.346
Aug. 6	76.0	71.0	.400	3.12	.434	.301	76.7	76.3	.527	2.08	.352	.336
Aug. 7	77.8	74.3	.516	2.43	.342	.349	78.4	78.0	.534	1.62	.344	.313
Aug. 8	79.6	72.5	.370	4.65	.443	.340	80.1	77.4	.485	2.10	[5] .399	.364
Aug. 9	74.9	73.0	.439	2.52	.390	.301	75.0	76.7	.498	1.68	.314	.296
Aug. 10	74.2	73.5	.424	2.73	.334	.300	74.6	77.2	.468	1.82	.298	.285
Aug. 11	79.9	74.3	.479	2.92	.396	.350	79.7	78.2	.548	1.95	.320	.342
Aug. 12	81.4	75.5	.562	2.52	.421	.385	81.6	77.2	.562	1.68	.340	.334
Aug. 13	82.0	76.6	.586	1.97	.359	.366	82.0	78.2	.596	1.31	.289	.330
Total	2,352.7	2,215.1	14.995	80.02	11.926	10.444	2,355.9	2,337.2	17.040	53.37	10.432	10.274
Mean	78.42	73.83	.4998	2.667	.3975	.3481	78.53	77.91	.5680	1.779	.3477	.3424

[1] Period from July 15 to July 31 based on direct readings on anemometers at two stations, and on curve values at third station.
[2] Equivalent depth on reservoir of difference between inflow and outflow.
[3] Air temperature for Colorado-type land pan and circular sunken pan same as for Weather Bureau pan.
[4] Partially estimated, calf drank from pan.
[5] Partially estimated, water splashed out of pan during windstorm.

In Table 17 the air and water temperatures and the differences in vapor pressure are the weighted means of the 7 a. m., 7 p. m., and following 7 a. m. readings for the 24-hour period. The water-surface wind velocities are those for the 24-hour period. They were obtained from the indicated velocities by use of the anemometer diagram (fig. 15), except in the case of the Weather Bureau tank, where the direct readings of the anemometer were used because the cups of the anemometer were approximately at the elevation of the top of the tank. The indicated wind velocities at the land pan anemometer were divided by 1.4 to determine the water-surface velocities for the Colorado tank and the circular sunken pan, and by 1.5 for the floating pan. The mean indicated wind velocities, as determined by the land pan anemometer and the two reservoir anemometers, were divided by 1.5 to get the mean surface velocities for the reservoir. One of the reservoir anemometers which was noticeably slow was calibrated by comparing it with a standard anemometer and the indicated velocities corrected accordingly.

The observed evaporation from the pans is in each case the difference between the 7 a. m. readings, corrected for the variation in the time interval. The reservoir evaporation is the mean loss determined from the readings at the three gages, corrected for variations in the time interval and for the inflow and outflow. The correction for inflow and outflow was determined by dividing the net inflow for the 24-hour period, in acre-inches, by the area of the water surface in acres.

The computed reservoir evaporation was obtained by substituting the meteorological data pertaining to the reservoir in formula 11,

$$E=0.771\ (1.465-0.0186\ B)\ (0.44+0.118\ W)\ (e_s-e_d), \tag{11}$$

while for the tanks the data applicable to the particular tank was substituted in formula 10,

$$E=(1.465-0.0186\ B)\ (0.44+0.118\ W)\ (e_s-e_d). \tag{10}$$

A study of Table 17 shows that the maximum evaporation occurred from the Weather Bureau pan and the minimum from the reservoir. The table also shows that the evaporation from the floating pan was almost identical with that from the sunken pan having the same size and shape. This fact, which was also noted in the experimental work at Fort Collins, Colo., seems to indicate that the sunken pan gives equally accurate determinations of reservoir evaporation, and it has the advantage of being much easier to maintain.

The computed evaporation was in general higher than the observed evaporation from the reservoir. This was also true for the Colorado pan and the circular sunken pan. The reverse was true for the Weather Bureau pan. The observed and the computed evaporation from the floating pan, however, agreed very closely. The lack of agreement in the other cases was probably due to the fact that the meteorological observations were taken only twice daily, and consequently the resulting means were probably not the true means. A similar lack of agreement was noted in the Fort Collins experiments when the observations were taken but twice daily.

The mean water temperature of the reservoir was higher than that of the evaporation pans, particularly the Weather Bureau pan, the temperature of which dropped materially during the night whereas the water in the reservoir changed only a few degrees. The air temperature was also higher for the reservoir than for the pans; this is accounted for by the fact that the readings at two of the reservoir stations were taken after 7 o'clock in the morning and before 7 in the evening since they were located several miles from the spillway.

The mean values of the observed and computed evaporation for the period, the ratios of the evaporation from the various pans to that from East Park Reservoir, and the ratios obtained from similar experiments elsewhere, are given for comparison in Table 18. The computed evaporation from the reservoir, the Colorado pan, and the 4-foot circular pan, exceeded the observed evaporation by 12.6, 8.5, and 12.7 per cent, respectively, but the computed evaporation from the Weather Bureau pan and from the floating pan was less than the observed evaporation by 12.4 and 1.5 per cent, respectively. Although the agreement is not perfect the results show that it is possible to compute the evaporation from a large water surface or from a small pan with reasonable accuracy even though the meteorological observations were made but twice daily. Had it been possible to continue the observations over a period sufficient to cover a wide range of meteorological conditions, a close agreement might reasonably be expected.

The ratios of the losses by evaporation from the various pans to the loss from the East Park Reservoir show that the Weather Bureau pan figure requires the greatest correction to reduce it to the equivalent reservoir evaporation. The ratio for the Weather Bureau pan, however, agrees remarkably with the results of the comparison between the Weather Bureau pan, the 85-foot circular reservoir at Fort Collins, Colo., and a 12-foot sunken pan at Denver (*20*). The ratio for the Colorado pan also is consistent with the results obtained at Fort Collins and Denver.

TABLE 18.—*Comparison of mean observed and computed evaporation from East Park Reservoir and from various types of evaporation pans at Stonyford, Calif., and ratios of observed evaporation from pans to observed evaporation from East Park Reservoir, from the 85-foot circular reservoir at Fort Collins, Colo., and from a 12-foot circular pan at Denver, Colo.*

Type and dimensions of pan	Evaporation at Stonyford, Calif. (mean values)			Ratio of observed evaporation of pan to— (mean values)		
	Observed, in 24 hours	Computed, in 24 hours	Deviation	East Park Reservoir	Circular reservoir 85 feet in diameter	Circular pan 12 feet in diameter
	Inch	*Inch*	*Per cent*			
East Park Reservoir, 1,800 acres	0.2728	[1] 0.3081	+12.6			
Colorado sunken pan, 36 inches square, 18 inches deep	.3653	[2] .3962	+8.5	[3] 1.326	1.266	[4] 1.259
Circular sunken pan, 4 feet in diameter, 3 feet deep	.3488	[2] .3931	+12.7	1.279		
Weather Bureau class A land pan	.3975	[2] .3481	−12.4	1.457	1.427	1.421
Circular floating pan, 4 feet in diameter, 10 inches deep	.3477	[2] .3424	−1.5	1.275		[5] 1.035

[1] Evaporation computed by formula 11.
[2] Evaporation computed by formula 10.
[3] Ratio based on period from July 9 to Aug. 13.
[4] Colorado-type sunken tank at Denver laboratory, 3 feet deep.
[5] Circular floating pan in Washington Park Lake more than one-half mile from 12-foot pan.

The ratios for the floating pan of the Weather Bureau type and the circular sunken pan of the same diameter are almost identical. Although no comparison between pans of these types was made at Fort Collins, a comparison was made between the Geological Survey floating pan and the Colorado sunken pan, each of which was 3 feet square and 18 inches deep. The ratios were found to be nearly identical, and they agreed very closely with those obtained at the East Park Reservoir for the 4-foot circular pans. This close agreement, however, was not shown by the Denver experiments which indicated that evaporation from the floating pans is much less than that from the sunken land pans. The reason for this discrepancy is not apparent.

The erratic results obtained from floating pans and the fact that the experiments at East Park Reservoir and at Fort Collins show that there is little difference between the evaporation from a floating pan and that from a similar sunken pan, suggest the advisability of discontinuing the use of the floating pan.

In view of the consistent ratios obtained for the Weather Bureau class A land pan and the Colorado sunken land pan at East Park Reservoir, as well as at Fort Collins and Denver, it seems safe to use these ratios in determining the equivalent reservoir evaporation from the measured evaporation from these pans.

COMPUTATION OF EVAPORATION FROM METEOROLOGICAL DATA

Evaporation records have been taken by various Federal agencies—the Geological Survey, the Bureau of Reclamation, the Weather Bureau, and the Bureau of Plant Industry—as well as by other public and private agencies at various points in the United States. These records do not all include complete meteorological data, but in many cases the data necessary for computing the evaporation are available or may be approximated. By comparing the observed evaporation at these stations with the evaporation as computed from the meteorological data by formula 10, it is possible to determine the accuracy of this formula. Since it is based on the mean meteorological data it is obvious that if the values used therein are not the true means, the true evaporation will not result except in special cases where there are compensating factors.

To compute the evaporation from a standard tank, the mean values of the barometric pressure, the wind velocity at the water surface, and the vapor pressure of saturated air at the temperature of the water surface and at the temperature of the dew point must be known with reasonable accuracy. As the elevation of most stations is known within 100 feet, it is easy to determine the mean barometer at 32° F. by reference to tables (*32, p. 134–139*). The other factors must be obtained by observations.

The wind velocity is usually obtained from an anemometer near the evaporation tank or from the records of the nearest Weather Bureau station. In either case, unless the anemometer cups are at the same distance above the ground as the water surface, it is necessary to reduce the observed wind to the water-surface wind. Only an approximation can be made because the relative wind velocities at different altitudes vary with the wind and with the season (*17*). From the results of observations on the wind velocity at different heights at Fort Collins and at other points, the diagram (fig. 15) was prepared which shows approximately the relative wind velocities at various elevations.

The mean of the maximum and minimum temperatures of the water surface is ordinarily taken as the mean water temperature, though the mean of readings taken at 12-hour intervals is also used. Unfortunately, water-temperature records are frequently neglected. In that case it is necessary to use the mean air temperature, even though the monthly mean temperature of the air is seldom the same as the monthly mean water temperature, as is shown in the summary of the results of observations taken at Fort Collins in Table 15. Corrections to be applied to air-temperature observations at different hours of the day to obtain true mean air temperature have been determined (*4*).

When the mean temperature of the water surface has been determined, either by direct measurement or by assuming that it is the same as the mean air temperature, the vapor pressure may be obtained by reference to tables (*23*) prepared for that purpose provided either the dew point, relative humidity, or wet-and dry-bulb psychrometer readings are available. The relative humidity is usually reported, and to find the vapor pressure it is then only necessary to multiply the vapor pressure of saturated air at the temperature of the air, by the relative humidity. Unfortunately the relative humidity varies throughout the day, but it has been observed by the Weather Bureau (*10*) that the means of the observations at 8 a. m. and 8 p. m., seventy-fifth meridian time, are quite close to the true means. For that reason, humidity observations are usually taken at those hours. Approximate mean values may be obtained from observations taken at other times by applying corrections that have been determined by the Weather Bureau (*10*). In case the relative humidity is known and the temperature of the water unknown, it is possible to obtain an approximate value of the difference in vapor pressure by multiplying the pressure of saturated vapor at the mean temperature of the air by the complement of the relative humidity expressed as a ratio—that is, the difference between the humidity and unity.

In case the evaporation observations have been made on other than the standard evaporation tanks, the formula may still be used so long as the size of the evaporation tank does not differ greatly from that of the standard tanks, because the effects of variations in size are taken care of by changes in the factors that influence evaporation. Under these circumstances the observations must, of course, be made on the tank itself and not approximated from other records.

For the purpose of testing formula 10, representative series of observations for which complete meteorological data could be obtained were chosen from the available records. The evaporation was then computed, and comparisons were made with the observed values. The results of these comparisons are given in Table 19. The values of the monthly mean observed and computed evaporation differ considerably, but with few exceptions the yearly averages agree reasonably well. The mean deviation is +1.77 per cent. In those instances where large differences occur, no satisfactory explanation of the discrepancies has been found.

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TABLE 19.—*Pertinent mean monthly meteorological data, and evaporation as observed and as computed from formula 10, at various stations in the United States*

Month	Temperature		Relative humidity	Vapor pressure of water, e_s	Vapor pressure of air, e_d	Vapor pressure difference, e_s-e_d	Wind velocity	Ground wind velocity	Evaporation per 24 hours	
	Air	Water							Observed	Computed
	°F.	°F.	Per cent	Inch of mercury	Inch of mercury	Inch of mercury	Miles per hour	Miles per hour	Inch	Inch
YUMA EVAPORATION STATION, ARIZ., 1917–1923 [1]										
January	51.1		[2] 47.0	0.375	0.176	0.199		1.44	0.099	0.110
February	54.6		46.2	.426	.197	.229		1.66	.141	.133
March	58.7		40.1	.494	.198	.296		1.87	.188	.178
April	64.0		37.4	.595	.223	.372		2.13	.253	.234
May	69.9		38.6	.729	.281	.448		1.40	.266	.247
June	78.7		37.4	.979	.366	.613		.96	.300	.308
July	87.0		46.4	1.280	.594	.686		1.31	.336	.371
August	85.7		52.1	1.228	.640	.588		1.40	.305	.324
September	79.9		50.1	1.018	.510	.508		1.18	.243	.268
October	68.7		46.7	.700	.327	.373		.99	.171	.189
November	57.6		45.5	.475	.216	.259		1.02	.105	.132
December	52.6		51.5	.396	.204	.192		1.17	.080	.101
Mean									.2072	.2162
Deviation, per cent									+4.3	
YUMA CITRUS STATION, ARIZ., 1921–1923 [3]										
January	53.2		[2] 47.0	0.405	0.190	0.215		2.41	0.136	0.142
February	58.5		46.2	.490	.226	.264		3.28	.217	.198
March	61.8		40.1	.551	.221	.330		3.52	.281	.257
April	66.3		37.4	.645	.241	.404		4.01	.367	.335
May	75.9		38.6	.893	.345	.548		3.70	.462	.438
June	83.8		37.4	1.156	.432	.724		3.38	.530	.552
July	84.9		46.4	1.197	.555	.642		4.05	.565	.536
August	90.5		52.1	1.430	.745	.685		3.28	.482	.515
September	84.8		50.1	1.194	.599	.595		2.57	.395	.402
October	72.4		46.7	.794	.371	.423		1.91	.283	.256
November	61.3		45.5	.541	.246	.295		1.99	.183	.181
December	55.2		51.5	.435	.224	.211		2.27	.128	.136
Mean									.3357	.3290
Deviation, per cent									−2.0	
CHILLICOTHE, TEX., 1916–1919 [4]										
April	60	59		0.499	0.280	0.219	10.0	[5] 6.9	0.226	0.258
May	70	68		.684	.400	.284	9.0	6.2	.268	.313
June	80	76		.896	.507	.389	7.2	5.0	.312	.377
July	84	80		1.022	.554	.468	6.0	4.1	.344	.406
August	84	79		.989	.529	.460	6.1	4.2	.345	.405
September	73	74		.838	.480	.358	6.0	4.1	.240	.311
Mean									.2892	.3450
Deviation, per cent									+19.3	
EDGELEY, N. DAK., 1911–1914 [6]										
April	44	46		0.310	0.200	0.110	9.4	[5] 6.5	0.132	0.125
May	54	56		.448	.298	.150	6.6	4.6	.150	.139
June	64	69		.707	.450	.257	5.8	4.0	.187	.220
July	68	72		.783	.489	.294	5.0	3.4	.207	.233
August	64	68		.684	.460	.224	4.3	3.0	.155	.167
September	55	58		.482	.348	.134	5.2	3.6	.124	.109
Mean									.1592	.1655
Deviation, per cent									+4.0	

See footnotes at end of table.

TABLE 19.—*Pertinent mean monthly meteorological data, and evaporation as observed and as computed from formula 10, at various stations in the United States*—Continued

Month	Temperature		Relative humidity	Vapor pressure of water, e_s	Vapor pressure of air, e_d	Vapor pressure difference, e_s-e_d	Wind velocity	Ground wind velocity	Evaporation per 24 hours	
	Air	Water							Observed	Computed
WILLISTON, N. DAK., 1911-1914 [7]										
	°F.	°F.	Per cent	Inch of mercury	Inch of mercury	Inch of mercury	Miles per hour	Miles per hour	Inch	Inch
April	46	49	--------	0.347	0.204	0.143	8.2	[5] 5.7	0.162	0.151
May	53	56	--------	.448	.259	.189	7.8	5.4	.176	.193
June	67	69	--------	.707	.413	.294	6.6	4.6	.245	.275
July	67	70	--------	.732	.404	.328	5.0	3.4	.249	.262
August	64	67	--------	.661	.401	.260	4.9	3.4	.186	.208
September	54	55	--------	.432	.302	.130	5.2	3.6	.124	.107
Mean									.1903	.1993
Deviation, per cent									+4.7	
HAYS, KANS., 1909-1912 [8]										
April	52	51	--------	0.373	0.224	0.149	11.4	[5] 7.9	0.228	0.194
May	62	62	--------	.555	.359	.196	10.2	7.0	.252	.236
June	73	71	--------	.757	.480	.277	7.5	5.2	.295	.277
July	79	77	--------	.926	.576	.350	6.4	4.4	.313	.319
August	76	75	--------	.866	.547	.319	7.0	4.8	.300	.305
September	68	66	--------	.638	.429	.209	7.7	5.3	.233	.212
Mean									.2702	.2572
Deviation, per cent									−4.8	--------
HAYS, KANS., 1913-1916 [9]										
April	53	53	--------	0.402	0.277	0.125	9.9	[5] 6.8	0.176	0.147
May	61	63	--------	.575	.391	.184	8.5	5.9	.204	.199
June	71	72	--------	.783	.535	.284	8.2	5.7	.257	.262
July	78	77	--------	.926	.542	.384	7.0	4.8	.341	.367
August	78	75	--------	.866	.500	.366	7.0	4.8	.329	.350
September	67	67	--------	.661	.423	.238	7.7	5.3	.238	.241
Mean									.2575	.2610
Deviation, per cent									+1.4	--------
DEER FLAT, IDAHO, 1916-1923 [10]										
April	49.7	--------	[11] 54.9	0.356	0.195	0.161	--------	4.92	0.184	0.157
May	57.7	--------	52.8	.476	.251	.225	--------	3.47	.182	.183
June	65.1	--------	48.3	.618	.298	.320	--------	1.98	.227	.207
July	73.0	--------	37.8	.810	.306	.504	--------	1.31	.257	.288
August	70.6	--------	39.4	.746	.294	.452	--------	0.97	.231	.240
September	59.5	--------	47.0	.508	.239	.269	--------	1.44	.165	.157
October	50.2	--------	58.9	.362	.213	.149	--------	1.90	.093	.095
November	38.7	--------	66.0	.234	.154	.080	--------	2.34	.036	.055
December	31.7	--------	74.2	.178	.132	.046	--------	3.26	.027	.036
Mean									.1556	.1576
Deviation, per cent									+1.3	--------

See footnotes at end of table.

TABLE 19.—*Pertinent mean monthly meteorological data, and evaporation as observed and as computed from formula 10, at various stations in the United States*—Continued

DICKINSON, N. DAK., 1909–1912 [12]

Month	Temperature, Air	Temperature, Water	Relative humidity	Vapor pressure of water, e_s	Vapor pressure of air, e_d	Vapor pressure difference, $e_s - e_d$	Wind velocity	Ground wind velocity	Evaporation per 24 hours, Observed	Evaporation per 24 hours, Computed
	°F.	*°F.*	*Per cent*	*Inch of mercury*	*Inch of mercury*	*Inch of mercury*	*Miles per hour*	*Miles per hour*	*Inch*	*Inch*
April	42	45		0.299	0.188	0.111	8.4	[5] 5.8	0.146	0.120
May	51	54		.417	.243	.174	9.2	6.3	.166	.198
June	63	67		.661	.398	.263	6.9	4.8	.205	.254
July	66	70		.732	.405	.327	6.2	4.3	.236	.297
August	63	66		.638	.396	.242	6.0	4.1	.192	.215
September	54	56		.448	.287	.161	6.5	4.5	.127	.150
Mean									.1787	.2057
Deviation, per cent									+15.1	

GARDEN CITY, KANS., 1910–1913 [13]

Month	Temperature, Air	Temperature, Water	Relative humidity	Vapor pressure of water, e_s	Vapor pressure of air, e_d	Vapor pressure difference, $e_s - e_d$	Wind velocity	Ground wind velocity	Evaporation per 24 hours, Observed	Evaporation per 24 hours, Computed
April	54	54		0.417	0.224	0.193	11.4	[5] 7.9	0.204	0.257
May	64	63		.575	.338	.237	11.1	7.7	.283	.310
June	73	72		.783	.430	.353	9.5	6.6	.328	.417
July	79	75		.866	.508	.358	8.6	5.9	.367	.395
August	77	74		.838	.488	.350	7.6	5.2	.322	.358
September	67	66		.638	.390	.248	8.4	5.8	.247	.270
Mean									.2918	.3345
Deviation, per cent									+14.6	

NORTH PLATTE, NEBR., 1908–1911 [14]

Month	Temperature, Air	Temperature, Water	Relative humidity	Vapor pressure of water, e_s	Vapor pressure of air, e_d	Vapor pressure difference, $e_s - e_d$	Wind velocity	Ground wind velocity	Evaporation per 24 hours, Observed	Evaporation per 24 hours, Computed
April	49	50		0.360	0.200	0.160	9.6	[5] 6.6	0.198	0.189
May	57	57		.465	.298	.167	9.3	6.4	.222	.194
June	69	68		.684	.474	.210	8.8	6.1	.290	.236
July	72	73		.810	.565	.245	6.9	4.8	.282	.239
August	71	70		.732	.538	.194	7.1	4.9	.250	.192
September	66	64		.595	.399	.196	7.6	5.2	.221	.200
Mean									.2438	.2083
Deviation, per cent									−14.6	

NORTH PLATTE, NEBR., 1915–1916 [15]

Month	Temperature, Air	Temperature, Water	Relative humidity	Vapor pressure of water, e_s	Vapor pressure of air, e_d	Vapor pressure difference, $e_s - e_d$	Wind velocity	Ground wind velocity	Evaporation per 24 hours, Observed	Evaporation per 24 hours, Computed
April	50	51		0.373	0.243	0.130	8.0	[5] 5.5	0.178	0.137
May	56	56		.448	.292	.156	7.9	5.4	.208	.163
June	64	66		.638	.432	.206	7.5	5.2	.217	.211
July	74	74		.838	.539	.299	7.1	4.9	.284	.295
August	70	73		.810	.498	.312	5.0	3.4	.222	.255
September	62	64		.595	.382	.213	6.4	4.4	.186	.198
Mean									.2158	.2098
Deviation, per cent									−2.9	

See footnotes at end of table.

TABLE 19.—*Pertinent mean monthly meteorological data, and evaporation as observed and as computed from formula 10, at various stations in the United States*—Continued

ARDMORE, S. DAK., 1913–1916 [16]

Month	Temperature		Relative humidity	Vapor pressure of water, e_s	Vapor pressure of air, e_d	Vapor pressure difference, e_s-e_d	Wind velocity	Ground wind velocity	Evaporation per 24 hours	
	Air	Water							Observed	Computed
	°F.	*°F.*	*Per cent*	*Inch of mercury*	*Inch of mercury*	*Inch of mercury*	*Miles per hour*	*Miles per hour*	*Inch*	*Inch*
April	47	49	--------	0.347	0.228	0.119	6.9	[5] 4.8	0.129	0.117
May	54	59	--------	.499	.277	.222	7.0	4.8	.175	.219
June	63	67	--------	.661	.381	.280	6.0	4.1	.235	.254
July	72	74	--------	.838	.412	.426	5.3	3.7	.273	.366
August	70	70	--------	.732	.388	.344	4.6	3.2	.241	.276
September	61	62	--------	.555	.314	.241	5.6	3.9	.204	.213
Mean	--------	--------	--------	--------	--------	--------	--------	--------	.2095	.2408
Deviation, per cent	--------	--------	--------	--------	--------	--------	--------	--------	+14.9	--------

AMARILLO, TEX., 1911–1914 [17]

Month	Air	Water	Relative humidity	e_s	e_d	e_s-e_d	Wind velocity	Ground wind velocity	Observed	Computed
April	55	54	--------	0.417	0.212	0.205	10.0	[5] 6.9	0.240	0.252
May	66	64	--------	.595	.324	.271	9.5	6.6	.295	.324
June	73	71	--------	.757	.444	.313	8.7	6.0	.314	.352
July	77	74	--------	.838	.487	.351	7.4	5.1	.322	.358
August	76	74	--------	.838	.458	.380	6.9	4.8	.305	.375
September	67	67	--------	.661	.393	.268	7.2	5.0	.232	.270
Mean	--------	--------	--------	--------	--------	--------	--------	--------	.2847	.3218
Deviation, per cent	--------	--------	--------	--------	--------	--------	--------	--------	+13.0	--------

AGRICULTURAL COLLEGE, N. MEX., 1918–1926 [18]

Month	Air	Water	Relative humidity	e_s	e_d	e_s-e_d	Wind velocity	Ground wind velocity	Observed	Computed
January	42.1	--------	52	0.267	0.139	0.128	--------	2.01	0.092	0.085
February	46.2	--------	52	.312	.162	.150	--------	2.81	.161	.113
March	53.0	--------	46	.402	.185	.217	--------	3.30	.239	.176
April	60.5	--------	42	.526	.221	.305	--------	3.31	.312	.248
May	69.1	--------	40	.710	.284	.426	--------	2.22	.358	.293
June	78.2	--------	42	.963	.404	.559	--------	1.94	.397	.367
July	80.4	--------	54	1.035	.559	.476	--------	1.90	.360	.310
August	78.6	--------	58	.976	.566	.410	--------	1.40	.316	.243
September	72.5	--------	59	.797	.470	.327	--------	1.46	.270	.196
October	61.5	--------	56	.545	.305	.240	--------	1.58	.191	.147
November	49.3	--------	55	.351	.193	.158	--------	1.83	.121	.102
December	42.1	--------	53	.267	.141	.126	--------	1.94	.081	.083
Mean	--------	--------	--------	--------	--------	--------	--------	--------	.2415	.1969
Deviation, per cent	--------	--------	--------	--------	--------	--------	--------	--------	−18.5	--------

DALHART, TEX., 1909–1912 [19]

Month	Air	Water	Relative humidity	e_s	e_d	e_s-e_d	Wind velocity	Ground wind velocity	Observed	Computed
April	52	53	--------	0.402	0.181	0.221	10.3	[5] 7.1	0.274	0.277
May	62	61	--------	.536	.265	.271	9.7	6.7	.308	.327
June	72	70	--------	.732	.379	.353	8.5	5.9	.365	.393
July	77	75	--------	.866	.450	.416	7.4	5.1	.356	.425
August	74	74	--------	.838	.460	.378	7.0	4.8	.318	.373
September	67	67	--------	.661	.338	.323	7.0	4.8	.265	.318
Mean	--------	--------	--------	--------	--------	--------	--------	--------	.3143	.3522
Deviation, per cent	--------	--------	--------	--------	--------	--------	--------	--------	+12.1	--------

See footnotes at end of table.

TABLE 19.—*Pertinent mean monthly meteorological data, and evaporation as observed and as computed from formula 10, at various stations in the United States*—Continued

Month	Temperature: Air	Temperature: Water	Relative humidity	Vapor pressure of water, e_s	Vapor pressure of air, e_d	Vapor pressure difference, e_s-e_d	Wind velocity	Ground wind velocity	Evaporation per 24 hours: Observed	Evaporation per 24 hours: Computed
	°F.	°F.	Per cent	Inch of mercury	Inch of mercury	Inch of mercury	Miles per hour	Miles per hour	Inch	Inch
DALHART, TEX., 1913-1916 [20]										
April	53	54		0.417	0.254	0.163	8.6	[5] 5.9	0.222	0.181
May	62	63		.575	.392	.183	8.2	5.7	.299	.200
June	73	73		.810	.471	.339	6.8	4.7	.317	.331
July	76	76		.896	.555	.341	7.1	4.9	.337	.340
August	74	76		.896	.524	.372	6.0	4.1	.301	.337
September	66	68		.684	.411	.273	6.8	4.7	.237	.266
Mean									.2855	.2758
Deviation, per cent									−3.5	
TUCUMCARI, N. MEX., 1913-1916 [21]										
April	56	52		0.387	0.222	0.165	7.5	[5] 5.2	0.222	0.170
May	66	61		.536	.270	.266	7.4	5.1	.313	.272
June	74	69		.707	.381	.326	7.2	5.0	.355	.329
July	78	73		.810	.450	.360	5.4	3.7	.334	.309
August	76	72		.783	.454	.329	4.7	3.2	.293	.264
September	69	65		.616	.359	.257	5.2	3.6	.244	.218
Mean									.2935	.2603
Deviation, per cent									−11.3	
AKRON, COLO., 1908-1911 [22]										
April	48	49		0.347	0.180	0.167	8.6	[5] 5.9	0.181	0.188
May	54	56		.448	.232	.216	9.1	6.3	.223	.253
June	66	68		.684	.350	.334	7.7	5.3	.276	.352
July	71	73		.810	.405	.405	6.5	4.5	.302	.389
August	68	68		.684	.404	.280	6.4	4.4	.262	.266
September	63	63		.575	.295	.280	6.8	4.7	.228	.276
Mean									.2453	.2873
Deviation, per cent									+17.1	
FORT COLLINS, COLO., 1890-1928 [23]										
April [24]	45.3	49.7				0.175		[25] 2.07	0.138	0.120
May	54.1	59.7				.231		1.57	.160	.144
June	63.0	69.7				.312		1.10	.182	.178
July	68.2	75.3				.353		.92	.187	.194
August	67.3	73.6				.332		.88	.176	.181
September	59.1	65.6				.269		1.00	.147	.150
October	47.7	53.0				.177		1.21	.106	.103
Mean									.1566	.1529
Deviation, per cent									−2.4	
SANTA FE, N. MEX., 1916-1926 [26]										
January	29		60	0.160	0.096	0.064		2.75	0.049	0.051
February	33		59	.188	.111	.077		3.12	.076	.065
March	40		50	.247	.123	.123		3.49	.128	.110
April	47		44	.322	.142	.180		3.83	.205	.167
May	56		39	.448	.175	.273		3.39	.275	.238
June	65		38	.616	.234	.382		2.77	.338	.305
July	69		52	.707	.368	.339		1.90	.288	.234
August	67		54	.661	.357	.304		1.64	.260	.200
September	61		51	.536	.273	.263		1.75	.218	.177
October	50		50	.360	.180	.180		2.10	.155	.129
November	39		54	.237	.128	.109		2.40	.085	.082
December	31		60	.173	.104	.069		2.37	.045	.052
Mean									.1769	.1508
Deviation, per cent									−14.7	

See footnotes at end of table.

TABLE 19.—*Pertinent mean monthly meteorological data, and evaporation as observed and as computed from formula 10, at various stations in the United States*—Continued

WAGON WHEEL GAP, COLO., 1920–1926 [27]

Month	Temperature		Relative humidity	Vapor-pressure of water, e_s	Vapor pressure of air, e_d	Vapor pressure difference, $e_s—e_d$	Wind velocity	Ground wind velocity	Evaporation per 24 hours	
	Air	Water							Observed	Computed
	°F.	*°F.*	*Per cent*	*Inch of mercury*	*Inch of mercury*	*Inch of mercury*	*Miles per hour*	*Miles per hour*	*Inch*	*Inch*
June	51.4			0.379	0.215	0.164		2.5	0.140	0.130
July	54.4			.422	.305	.117		2.0	.110	.085
August	51.8			.384	.288	.096		1.7	.079	.067
September	46.0			.310	.201	.109		1.7	.060	.075
Mean									.0972	.0892
Deviation, per cent									−8.2	
Mean deviation, per cent									+1.77	

[1] Elevation, 127 feet; altitude factor, 0.91; U. S. Weather Bureau class A land pan; evaporation reported by Ivan E. Houk (*20*); meteorological records by the University of Arizona.
[2] Humidity record taken in Yuma, Ariz.
[3] Elevation, 181 feet; altitude factor, 0.91; U. S. Weather Bureau class A land pan; evaporation reported by Ivan E. Houk (*20*); meteorological records by University of Arizona.
[4] Elevation, 1,406 feet; altitude factor, 0.94; sunken land pan, 6 feet in diameter, 24 inches deep; evaporation reported by Robert E. Horton (*19*); meteorological records by Bureau of Plant Industry.
[5] Reduction factor of 0.689 used to obtain ground wind; anemometer approximately 24 inches above rims of pans.
[6] Elevation, 1,468 feet; altitude factor, 0.94; sunken land pan, 8 feet in diameter, 24 inches deep; evaporation reported by Robert E. Horton (*19*); meteorological record by Bureau of Plant Industry.
[7] Elevation, 1,875 feet; altitude factor, 0.95; sunken land pan, 8 feet in diameter, 24 inches deep; evaporation reported by Robert E. Horton (*19*); meteorological records by Bureau of Plant Industry.
[8] Elevation, 2,000 feet; altitude factor, 0.95; sunken land pan, 8 feet in diameter, 24 inches deep; evaporation reported by Robert E. Horton (*19*); meteorological records by Bureau of Plant Industry.
[9] Elevation, 2,000 feet; altitude factor, 0.95; sunken land pan, 8 feet in diameter, 24 inches deep; evaporation reported by Robert E. Horton (*19*); meteorological records by Bureau of Plant Industry.
[10] Elevation, 2,510 feet; altitude factor, 0.96; U. S. Weather Bureau class A land pan; evaporation reported by Ivan E. Houk (*20*); meteorological records by the Bureau of Reclamation, U. S. Department of the Interior.
[11] Relative humidity taken at Boise, Idaho.
[12] Elevation, 2,543 feet; altitude factor, 0.96; sunken land pan, 8 feet in diameter, 24 inches deep; evaporation reported by Robert E. Horton (*19*); meteorological records by Bureau of Plant Industry.
[13] Elevation, 2,836 feet; altitude factor, 0.97; sunken land pan, 8 feet in diameter, 24 inches deep; evaporation reported by Robert E. Horton (*19*); meteorological records by Bureau of Plant Industry.
[14] Elevation, 2,841 feet; altitude factor 0.97; sunken land pan, 8 feet in diameter, 24 inches deep; evaporation reported by Robert E. Horton (*19*); meteorological records by Bureau of Plant Industry.
[15] Elevation, 2,841 feet; altitude factor, 0.97; sunken land pan, 6 feet in diameter, 24 inches deep; evaporation reported by Robert E. Horton (*19*); meteorological records by Bureau of Plant Industry.
[16] Elevation, 3,557 feet; altitude factor, 0.98; sunken land pan, 6 feet in diameter, 24 inches deep; evaporation reported by Robert E. Horton (*19*); meteorological records by Bureau of Plant Industry.
[17] Elevation, 3,676 feet; altitude factor, 0.98; sunken land pan, 6 feet in diameter, 24 inches deep; evaporation reported by Robert E. Horton (*19*); meteorological records by Bureau of Plant Industry.
[18] Elevation, 3,863 feet; altitude factor, 0.98; U. S. Weather Bureau class A land pan; evaporation reported by Charles E. Linney (*22*); meteorological records by U. S. Weather Bureau.
[19] Elevation, 4,000 feet; altitude factor, 0.98; sunken land pan, 8 feet in diameter, 24 inches deep; evaporation reported by Robert E. Horton (*19*); meteorological records by Bureau of Plant Industry.
[20] Elevation, 4,000 feet; altitude factor, 0.98; sunken land pan, 8 feet in diameter, 24 inches deep; evaporation reported by Robert E. Horton (*19*); meteorological records by Bureau of Plant Industry.
[21] Elevation, 4,194 feet; altitude factor, 0.98; sunken land pan, 6 feet in diameter, 24 inches deep; evaporation reported by Robert E. Horton (*19*); meteorological records by Bureau of Plant Industry.
[22] Elevation, 4,650 feet; altitude factor, 0.99; sunken land pan, 8 feet in diameter, 24 inches deep; evaporation reported by Robert E. Horton (*19*); meteorological records by Bureau of Plant Industry.
[23] Elevation, 5,000 feet; altitude factor, 1; Colorado sunken land pan, 3 feet square, 3 feet deep; evaporation and meteorological records furnished by Colorado Agricultural Experiment Station.
[24] No record for April, 1890, 1891, and 1920.
[25] Anemometer, 18 inches high; corrected for instrumental error by anemometer comparison diagram and reduced to ground wind by factor 0.724.
[26] Elevation, 6,975 feet, altitude factor, 1.04; U. S. Weather Bureau class A land pan; evaporation reported by Charles E. Linney (*22*); meteorological records by U. S. Weather Bureau.
[27] Elevation, 9,610 feet; altitude factor, 1.08; U. S. Weather Bureau class A land pan; evaporation reported by C. G. Bates and A. J. Henry (*2*); meteorological records by U. S. Weather Bureau and Forest Service.

A study of the results obtained on the 85-foot circular reservoir at Fort Collins, Colo. (Table 14), indicates that with few exceptions the observed evaporation is less than the computed evaporation. The summary by months (Table 16) shows that on the average the observed evaporation is about 30 per cent less than the computed evaporation. Observations by Sleight at Denver, which were confirmed by experiments at Fort Collins, Colo., and Milford, Utah (p. 72), show that the evaporation per unit area under similar conditions is approximately constant when the diameter of the tank is greater than 9 feet. It seems evident, therefore, that if observations are made on a large reservoir or lake to determine the mean velocity of the wind at the water surface and the mean difference in vapor pressure, it would be possible to compute the evaporation from the reservoir or lake either by substituting the observed data in formula 10, and then reducing the result by 23 per cent, or by substituting directly in the formula

$$E=0.771\ (1.465-0.0186\ B)\ (0.44+0.118\ W)\ (e_s-e_d) \qquad (11)$$

as was done in computing the evaporation from East Park Reservoir. (Table 17.)

No difficulty should be encountered in obtaining the mean meteorological data for a lake or reservoir, but to check the accuracy of the evaporation as computed from these data the true evaporation must be known. Few records of this sort are at present available, but it is to be hoped that engineers connected with work where conditions are favorable for doing so will keep records of the evaporation loss and the necessary meteorological factors, in order that the accuracy of the method of determining the evaporation from large bodies of water may be tested, or a better solution of the problem devised.

SUGGESTIONS REGARDING EVAPORATION OBSERVATIONS

From the experience accumulated during the foregoing evaporation experiments, the following suggestions are offered in the interest of standardizing the procedure in making evaporation observations, and to assist the engineer in the choice of the type of tank best suited for carrying on evaporation experiments.

Of the four principal types of evaporation pans used in the United States, the United States Weather Bureau land pan is probably the one most commonly used, and it is satisfactory for most evaporation experiments. It is a circular tank 48 inches in diameter and 10 inches deep, made of 22-gage galvanized iron and supported on a grillage of timbers so that the bottom of the tank is approximately 6 inches above the ground surface. The tank is filled with water to within 2 inches of the top, and as soon as the depth has dropped 1 inch below this level the tank is refilled. The evaporation loss is measured by a special micrometer-hook gage in a stilling well which is placed in the tank and acts as support for the gage. This pan combines simplicity of design with ease of making observations. It is high enough above the ground so that water does not splash into it during rains, nor does it blow full of snow during snowstorms. Dust and trash do not blow into it as readily as into the sunken land tanks. The water in the pan being fully exposed to the air, its temperature follows the air temperature more closely than does that of the water in either the sunken or the floating tanks. Although this is advantageous in some cases, it makes it difficult to obtain the mean temperature of the water because of the rapid changes. A large number of these tanks have been installed in the United States, and much observational data are available from them. It is to be regretted, however, that only a few have been installed in the eastern part of the United States.

From the standpoint of making comparisons with known data on evaporation losses, the Weather Bureau tank is probably the one best adapted to the study of evaporation from water surfaces. While not all of the data necessary for making such comparisons are obtained by the Weather Bureau, the necessary information can usually be approximated from the records of near-by Weather Bureau stations. The rate of evaporation from this tank is much higher than that from a lake or reservoir under similar conditions, and consequently a large correction must be made in determining the reservoir equivalent. The correction factor has, however, been determined under a wide range of conditions with very consistent results.

The type of pan developed by the Bureau of Plant Industry of the United States Department of Agriculture is also very satisfactory. It is a cylindrical tank 6 feet in diameter and 2 feet deep, made of 22-gage galvanized iron and sunk in the ground so that 4 inches of the rim projects above the surface. The water surface is maintained at approximately 4 inches below the rim, or at about the elevation of the ground surface. Whenever the water surface deviates more than one-half inch from this level, owing either to evaporation or to precipitation, it is brought back to the standard level. Evaporation is measured by a micrometer-point gage mounted on the stilling well which is attached to the outside of the tank.

Evaporation records, including complete meteorological data (water temperature records discontinued after 1916), are available for this type of tank at each of the 28 dry-land stations of the Bureau of Plant Industry in the western half of the United States. Evaporation values as obtained from the Plant Industry tank do not vary through so wide a range as those from the Weather Bureau pan, and the variation from the evaporation from a large water surface is also less; consequently the factor required to compute the reservoir equivalent is nearer unity. The water temperature changes more slowly than does that of the Weather Bureau pan, and it is therefore easier to determine the mean water temperature. Since the rim is 4 inches above the ground, the tank is protected to a considerable extent from splashing rain, drifting snow, and blowing dust and trash, although not so completely as the Weather Bureau pan.

The Plant Industry tank has the disadvantage of being larger and more expensive to build and install than the Weather Bureau pan. Another objection is that there are no records from it for the eastern part of the United States, nor has the factor for determining the reservoir equivalent been established under so wide a range of conditions as for some of the other types of tanks.

The Colorado pan has most of the advantages and disadvantages of the Plant Industry pan but has not been used as extensively as either of the pans just described. It is made of 18-gage galvanized iron and is 3 feet square and 3 feet deep, although an 18-inch depth may be used without detriment to the accuracy of the observations.

The tank is sunk in the ground so that the top is from 2 to 6 inches above the ground surface, but 4 inches would probably be more satisfactory for most conditions because it would tend to eliminate troubles due to drifting of snow, splashing of rain, and accumulation of dust and trash in the tank. The water in the tank is maintained at the elevation of the ground surface and should not be allowed to deviate more than 1 inch either way from this level. Evaporation is measured by a hook gage, and for accurate results a stilling well should be used.

The rate of evaporation from the Colorado tank is between the rates from the two tanks first mentioned. Since the tank is sunken the water temperature lags behind the air temperature. In this respect it approaches a large water surface more nearly than does the Weather Bureau pan. The correction factor for computing the reservoir equivalent has been determined under varying conditions with uniformly consistent results. The tank is easy to construct and is cheaper than the Plant Industry type.

The United States Geological Survey floating tank has been used chiefly in the study of evaporation from lakes and reservoirs. It is made of 18-gage galvanized iron and is 3 feet square and 18 inches deep. The tank is supported by two cylindrical floats 9 inches in diameter and 42 inches long, so that it floats in the water with 3 inches of the rim above the water surface. The water inside the evaporation pan is maintained at the same level as that outside. The pan is floated inside a raft 14 by 16 feet, which is supported by barrels at the corners. Surging in the pan is reduced by two diagonal diaphragms beneath the water surface. These diaphragms are perforated with 1-inch holes on 3-inch centers. A stilling well with a fixed point for determining the evaporation loss is located at the intersection of the diaphragms. A special measuring cup which holds just sufficient water to raise the water in the evaporation pan 0.01 inch, is used for determining evaporation.

The Geological Survey tank is not affected by drifting snow or splashing rain, and neither dust nor trash can blow into it. Being set in the water, the tank is subjected to conditions comparable to those existing in a large water surface, and consequently the factor for computing the reservoir equivalent should, it would seem, be nearer unity than the factors for the land tanks. Experimental results have been inconsistent, but they show that evaporation from a floating tank is almost identical with that from a sunken land pan of the same dimensions. Since the floating pan is relatively expensive to construct and difficult to maintain, and since it is constantly subject to being splashed full from outside waves or to being partly emptied by water splashing out of the tank because of the rolling of the pan, this type of tank is rapidly losing favor.

The evaporation from the Bureau of Plant Industry sunken pan probably approaches the evaporation from a large body of water more nearly than does that from any of the other standard types of land pans, but the exact factor for computing the reservoir equivalent has not been definitely determined for this pan. On the other hand, this factor has been determined experimentally for the Weather Bureau pan and the Colorado pan with very consistent results. For that reason, one or the other of these latter types of tanks should be chosen for determining the evaporation loss from a large water surface.

To obtain comparable and reliable evaporation data from any of these tanks, its location should be given careful consideration. The land tanks should be installed on a level area free from obstructions such as trees and buildings, and if the record is for the purpose of determining the equivalent reservoir evaporation, the location chosen should be representative of the conditions existing at the reservoir. The tanks should not be installed in isolated places at long distances from the observers' homes, or far from supplies of soft water. A close-mesh wire fence should be provided to protect the equipment.

If it is necessary to install a floating pan for any reason such as obtaining comparative evaporation data, the place chosen should be in an area protected from the full force of the waves, but the exposure to the wind should represent average conditions. Owing to the effect of altitude on the evaporation from all types of pans, the approximate elevation of the site chosen should be known.

Complete meteorological records should be kept and a standardized procedure followed in taking the observations, in order that comparisons may be made between the evaporation observations at different stations. This record should include the mean temperature of the air and of the water, wet- and dry-bulb air temperatures, wind movement, precipitation, and evaporation loss. The instruments required for taking these observations are as follows:

Two sets of maximum and minimum thermometers for determining the mean air and water temperatures, or

Two ordinary thermometers where observations can be taken twice daily at 12-hour intervals or oftener.

One psychrometer for determining the humidity.

One anemometer for recording the wind movement.

One rain gage for measuring the precipitation.

One gage for measuring the evaporation.

One instrument shelter for housing the air thermometers and the psychrometer.

Standard Weather Bureau practice should be followed in taking the observations. That bureau has prepared complete instructions (*21*) for the operation of the class A land-pan stations; observations on the other types of tanks should follow the same procedure as closely as the differences in the tanks will permit.

In addition to the records required by the Weather Bureau, the mean temperature of the water and the relative humidity of the air should be recorded. The mean water temperature may be determined either by the use of maximum and minimum thermometers floating in the water with their bulbs immersed about one-fourth inch beneath the surface, or by the use of ordinary thermometers similarly exposed. Maximum and minimum thermometers have the advantage of requiring but a single reading daily, whereas ordinary thermometers must be read at least twice daily, at 12-hour intervals, to obtain a fair average of the temperature. Maximum thermometers have, however, the disadvantage of being broken frequently by inexperienced observers. The sling, or rotating, psychrometer should be used in determining the humidity. The customary practice is to take the readings at 7 a. m. and 7 p. m. The mean resulting from these two readings is not ordinarily the true mean for the day, but it is usually impracticable to take readings more frequently.

The anemometer at a Weather Bureau class A land pan should be mounted on a standard support attached to the grillage of timbers upon which the pan rests. This places the cups of the anemometer at about 6 inches above the top of the tank. The standard practice of the Bureau of Plant Industry is to so place the anemometer that the cups are 24 inches above the top of the tank. The anemometer for the Colorado pan and for the Geological Survey pan should be so installed that their cups are approximately 18 inches above the surface of the ground or water.

The rain gage should be of the Weather Bureau type and should be installed in accordance with the bureau's instructions (*21*).

Special types of evaporation gages are ordinarily used in connection with the different evaporation pans, but any gage giving readings accurate to within 0.001 foot should be satisfactory.

Although the Weather Bureau recommends taking the observations once daily at 7 a. m., they should be taken oftener when humidity readings are included. Observations taken twice daily, usually at 7 a. m. and 7 p. m., are satisfactory for the most part, but where great accuracy is required observations should be taken more frequently.

SUMMARY

The calibrations of the optical evaporimeter used in measuring evaporation under still-air and controlled conditions in the laboratory and under fully exposed conditions outside, showed that in general the average maximum deviation from the mean values of the constants was between 4 and 5 per cent, although for 11 of the 29 calibrations the maximum deviation from the mean was 2 per cent or less.

Comparison of vapor pressures determined by the sling and by aspiration psychrometers indicated that the sling psychrometer gave consistently lower results. The mean difference was 4.08 per cent. This probably was due to the fact that the observations were not made at the same elevation above the water surface. A later comparison of the vapor pressures determined by sling and aspiration psychrometers with those determined by the Alluard dew-point hygrometer under more nearly comparable conditions showed that without exception the sling and aspiration psychrometers gave higher values, and that the mean deviation, which was nearly the same for all the psychrometers, was about 3 per cent.

For still-air conditions in the laboratory, there was no relation between the evaporation and the temperatures of air and water, but there was a definite relation between the difference in temperature and the evaporation, as there was also between the difference in vapor pressure and the evaporation.

Expansion and contraction due to temperature changes have a definite effect on evaporation observations but may be eliminated from the evaporation record by taking the means of the observations for 24-hour periods, because the rise and fall of the temperature in a 24-bour cycle will be nearly equal.

Tests on the effect on evaporation of expansion and contraction due to temperature changes showed that the evaporation from the oil film used to cover the water surface was about 2 per cent of the evaporation that occurred from a water surface under similar conditions.

Under conditions of controlled wind in the laboratory, evaporation bore no relation to the temperature of the air or of the water, or to the difference in temperature of the air and the water. However, a definite relation was found to exist between evaporation and wind velocity and between evaporation and difference in vapor pressure. This relation agrees reasonably well with the experimental data except in the cases where those data are known to be in error.

The experimental results from hourly observations outside, under fully exposed conditions, were not so consistent as those obtained inside, nor did the results agree so well with the results computed by formula 6, although the mean values check quite closely.

Observations at Fort Collins, Colo., on the evaporation from a heated water surface in winter indicated that Dalton's law holds for these conditions. The mean values showed that the evaporation from the heated water surface was about equal to the mean summer evaporation at Fort Collins.

Comparison of the observed and computed evaporation from ice in a pan 17½ inches in diameter, under controlled conditions in the laboratory, showed that when there was no perceptible air movement the observed evaporation loss was considerably less than the computed evaporation, but that when the air was agitated slightly by an electric fan the observed and computed evaporation agreed fairly well. When a definite air velocity was maintained over the surface of the ice, the computed evaporation was less than the observed evaporation. This may have been due to the roughening of the ice by the wind which caused an increase in the evaporating area. The rate of evaporation from ice varied between 0.0032 and 0.1423 inch per 24 hours.

Observations on the effect of altitude on evaporation, as indicated by the deviation from the evaporation formula at different points in the West with elevations of from 68 feet below, to 14,109 feet above sea level, show that for similar meteorological conditions there is a definite increase in evaporation as altitude increases. In making these observations it was discovered that the kind of paint used on the inside of the evaporation tank affected the rate of evaporation. The maximum deviation of the mean evaporation as computed by the formula and the mean observed evaporation corrected for known errors was 5.4 per cent.

Observations under similar conditions at Fort Collins, Colo., using the United States Geological Survey floating tank, the Colorado sunken tank, the United States Weather Bureau class A land pan, and the 85-foot circular reservoir showed that in general the maximum evaporation occurred from the Weather Bureau class A land pan, and the minimum from the reservoir. The evaporation from the Geological Survey floating tank agreed quite closely with that from the Colorado sunken tank.

Daily evaporation losses at Fort Collins, Colo., computed by formula 10 for the Geological Survey floating tank, the Colorado sunken tank, and the Weather Bureau class A land pan, agreed reasonably well with the observed losses from these tanks, but the computed loss from the 85-foot circular reservoir was with few exceptions greater than the observed evaporation.

The monthly mean observed and computed evaporation losses showed the same trend, but the results were more consistent. The mean deviations of the computed evaporation from the observed values for the entire period, for the 85-foot circular reservoir, the Geological Survey floating tank, the Colorado sunken tank, and the Weather Bureau class A land pan were, respectively, +29.7, −2.0, +2.9, and −1.6 per cent.

In observations at Stonyford, Calif., on the mean evaporation from East Park Reservoir, the Colorado sunken pan, the 4-foot circular sunken pan, the Weather Bureau class A land pan, and the 4-foot circular floating pan, the maximum evaporation occurred from the Weather Bureau pan, and the minimum from East Park Reservoir. The evaporation from the 4-foot floating pan was almost identical with that from the 4-foot sunken pan.

A comparison of the mean evaporation losses at Stonyford, Calif., computed by formula 10 for the Colorado sunken pan, the 4-foot circular sunken pan, the Weather Bureau class A land pan, and the 4-foot circular floating pan showed that the computed evaporation differed from the observed evaporation by respectively +8.5, +12.7, −12.4, and −1.5 per cent. The mean evaporation loss from East Park Reservoir, as computed by formula 11 for large water surfaces, was 12.6 per cent greater than the observed evaporation.

The computed results at Stonyford were not so accurate as those at Fort Collins, probably because the meteorological observations were taken but twice daily at Stonyford.

The ratios of the observed evaporation from the Colorado sunken pan to that from the East Park Reservoir, Calif. (1,800 acres), the 85-foot circular reservoir at Fort Collins, Colo., and the 12-foot circular sunken pan at Denver, Colo., were, respectively, 1.326, 1.266, and 1.259. For the Weather Bureau class A land pan (4 feet in diameter and 10 inches deep) these respective ratios were, 1.457, 1.427, and 1.421.

The ratio of the observed evaporation from the circular sunken pan to that from East Park Reservoir was 1.279.

The ratios of the observed evaporation from the circular floating pan to that from East Park Reservoir and the 12-foot circular pan at Denver were 1.275 and 1.035, respectively.

The ratios of the evaporation from the Geological Survey floating pan, to the evaporation from the 85-foot circular reservoir at Fort Collins and the 12-foot circular pan at Denver were 1.301 and 1.125, respectively.

It should be noted with reference to the above comparisons that in the Denver experiments the Colorado sunken pan was 36 inches deep instead of 18 inches, and that the circular floating pan and the Geological Survey floating pan were located in Washington Park Lake, more than one-half mile from the 12-foot circular pan.

The Geological Survey found a ratio of 1.470 between the evaporation from a Weather Bureau class A land pan and a circular tank 12 feet in diameter at Milford, Utah.

A comparison of the evaporation as computed from the meteorological data by formula 10 with the evaporation at various points in the United States observed by other agencies showed that the formula has a general application.

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